THE

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THE
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PARLIAMENTARY RESTRICTIONS ON ELECTRIC TRACTION DEVELOPMENTS.

SOME of those who have to do with electric traction will tell you, if asked how long it takes to carry out an electric traction scheme by private enterprise, that three years at least are required from start to finish, made up thus: one year for settling agreements with local authorities, one year for obtaining legislative powers, and one year for actual construction work, these being average periods only.

The last named period is, as a rule, short enough, and in the present congested state of the industry, it is the least possible time which can be given for any scheme of average size to be carried out. What, however, can be done in the way of abbreviating the rest of the three years?—to which indeed it has sometimes been found necessary to prefix another year, for coming to terms with what is usually a stick-in-the-mud directorate of an existing horse car line.

The Tramways Act lays down for one thing, clearly enough, that consents of local authorities must be a condition precedent to applying for powers by provisional order, and the same thing obtains with a bill. The Light Railways Act (under which powers have been obtained for a good many tramways pure and simple) specially disclaims such power of veto by the local authority, yet the Commissioners have repeatedly refused to grant orders by reason of opposition from local authorities.

A rank outsider of a philosophical turn of mind would at once say, "What is the use of worrying? It seems quite clear in this case that the Government is *agin* you, so why not cease from further exertion, and let the local authorities themselves do all the tramway work, bearing in mind the great bias in their favour on the part of the powers that be?"

Municipalisation may be all very well in its way, but one has only to see how the true development of electric traction gives rise to lines running through the areas of many local authorities, in order to recognise the impossibility of such a position. United action is not to be thought of: adjacent local authorities are always too jealous of one another to agree about anything except that they shall differ; and the field for private enterprise in electric traction, so far from being closed, is, as a matter of fact, hardly opened up as yet. There is and can be no true alternative to private enterprise in regard to the full development of electric lines except that of State ownership, and in this respect they resemble our railway lines and systems. No one has yet suggested that the various *local* authorities should purchase, take over or work the railways of this country, big or small; and no one ought to be so muddle-headed as not to see the tendency of electric lines to develop in a similar direction to that of the railways.

Returning to the main question, however, it seems more than time that legislation should—if the above reasoning be

correct—take a tendency towards easing the way for private enterprise. At present the tendency appears to be dead against it, and one may, therefore, justifiably consider the present moment an opportune one for taking some steps to bring about a better state of things all round.

For one reason, the Light Railways Act of 1896 expires this year, and must, therefore, either be renewed, amended, or dropped altogether. As a matter of fact, as our readers will doubtless know, the present Government has already introduced a Bill to continue and amend the Act, proposing amongst other matters a prolongation of the powers under the Act for a further period of five years, also the appointment of a second paid Commissioner, and an increase in the amount of Government contribution by way of special advances to light railways properly so called. Very much more than this, however, ought to be effected in the way of amendment if the Light Railways Act is to be of any real service for the development of electric traction; and, indeed, one would have thought that a new Parliament, with probably a long life before it, should be able to find time for dealing more elaborately and fully with the whole subject and both Acts, even allowing for all the fads and fancies that are brought forward to waste the time of Parliamentary sessions.

It, therefore, behoves those who wish to see electric traction put on a sound and fair footing, to use every effort possible in the way of forcing upon Parliament the conviction that matters at present are in a most unsatisfactory condition, and ought at once to be remedied. How can this best be done, and in what direction is improvement to be sought?

An answer to the first question is not very easy to give. True, there is a Tramways and Light Railways Association, which was formed a little while ago, but so far no public sign of movement in this direction has been made by it. Possibly steps are being taken in the matter, results of which will show themselves by and by; but it certainly seems imperatively necessary that those interested in the more rapid and easy development of electric traction should act at once if anything is to be done at all.

We would suggest that a general meeting of all concerned in the industry be called in order to give vent to expressions of opinion and experience with regard to the working of both the Tramways and the Light Railways Act. This might very properly be taken in hand by such a body as the London Chamber of Commerce, and one resultant action should be the appointment of a committee to go into the matter fully and draw up a report which might not only attract public attention to the subject, but also exercise some influence upon Government procedure.

In regard to the second point, or the question of what changes ought to be made, there is, of course, much to say and many details to discuss. Broadly speaking, however, in the first instance, the feeling seems pretty general that both Acts already mentioned have many good and advisable features, but are also loaded with impossible conditions, and that the best plan would be either to repeal them both and make one good Act out of the serviceable portions applicable to tramways, tramroads, and light railways strictly so-called, or else amend the Tramways Act in certain particulars and strengthen the Light Railways Act still more in several directions.

Taking the latter course, there are at least five distinct features which ought absolutely to be struck out of the Tramways Act, and these are the limitation of tenure to 21 years only; the consent of local authorities as a condition precedent; the terms of purchase under the 43rd clause (*i.e.*, "the *then* value," &c.); the limitation of a lease to 21 years only; and the necessity for obtaining consent of frontagers.

Doubtless there are plenty of other points which may be raised, but the above are the most important, and are those which have helped to militate so strongly against real development in tramway work of any kind.

Dealing with the Light Railways Act, which should then be utilised for light railways strictly so-called, the amendments which ought to be effected lie in the direction of taking out, and of avoiding in practice, all references, real or indirect, to the Tramways Act of 1870. The orders under this Act should, in regard to procedure, rather follow the routine of provisional orders made by the Board of Trade, or still better, the routine now worked out for provisional orders under the Scottish Private Legislature Procedure Act of 1899, with direct reference to Parliament rather than to the Board of Trade—a nondescript body which is already far too heavily taxed with work and obligations.

If, however, the only hope of electric traction interests is to lie in the Light Railways Act alone, then to enable the promotion and construction of street tramways under this Act, some very marked changes must be effected in this measure before it can give true satisfaction, and we hope to see these changes carried out during the present session when the subject comes up for consideration.

To begin with, there are two points in regard to which the practice has been absolutely at fault. First, a light railway application ought not to be refused a hearing or be thrown out because the consents of local authorities may not have been secured. The Commissioners or Parliament ought to very carefully consider the circumstances of the case before allowing non-consent or even active opposition to affect the whole procedure. The Light Railway Commissioners are, indeed, in essence, specially empowered to recommend the granting of an Order where no consent has been given, but frequently, as stated, the fact of such non-consent has proved sufficient to secure the failure of an application.

Then, applications have been refused a hearing simply because the lines to which they referred lay wholly each in the area of a single urban local authority. It is, perhaps, a stretch of imagination to call a suburban street tramway a "light railway," but if these lines cannot be economically constructed and worked under the Tramways Act, facility ought to be given for them in some other way; and hence the use made of the Light Railways Act.

The number of Commissioners ought to be increased, and they should be paid servants of the country, appointed for a reasonable term of years; and in that case they should be invested with fuller powers, not merely with respect to the details of new applications for light railways, but they should also be able to vary in connection therewith the existing powers of lines of which the light railways may be extensions or with which they may connect; and this even to the extent if necessary of giving compulsory running powers.

Such are a few of the alterations and amendments that a brief glance at the subject will permit us to mention; there are doubtless ten times as many, which those who have daily experience of the work will be able at once to suggest, and we hope sincerely that they will not only have the chance of bringing forward into prominent notice all the objectionable features in both Acts, but that they will also have the supreme satisfaction, before the session is finished, of seeing the result of their work in the shape of at least one suitably amended Act on the statute book, but preferably *two*.

Our Naval Boilers.

We now find Mr. Arnold-Forster labouring to prove the Belleville boiler not so bad as painted. In one breath he frankly and freely accepts the report of the Committee and proceeds to praise the Belleville boiler. Of course, the Committee's report was unpalatable. The *Times*, too, attacked the Committee and defended the boiler, but the *Engineer* will have none of it. For years the *Engineer* backed the Belleville. It did not matter that the tubes of the boiler were 150 diameters long, that they sloped at 2° or 3° only, and had nozzles at inlet and outlet. All these and other faults existed all along, but our contemporary has learned the truth at last, and does what is right in putting the Belleville in a class of its own, and all other water-tube boilers in another. We cannot do this; we hope the Belleville is alone in one class, but there are two other classes—large tube boilers and small tube boilers; and each of these classes has two divisions—those in which there is provision for preventing smoke, and those in which this is absent. There are thus really five main classes of water-tube boilers, and these, of course, shade off by more or less insensible gradations into each other. The *Engineer* now writes to reassure its readers on water-tube boilers generally, and to show them that the Belleville was, and is, *sui generis*. The pity of it all is that all the time the Admiralty were plunging the country into danger, the two heavy engineering journals were helping them on in face of the most obvious facts. Reassurance from sources that have been so easily led astray loses much of its value. The *Engineer* is like the newly-converted sinner, full of horror at the enormity of its past sins, and preaching repentance. *Engineering*, however, is in the position of the unconverted sinner, restrained from sin and thrust into saintly company, where it feels most uncomfortable. It hesitates to fly in the face of the Committee, yet would much like to do so.

Electrolysis and Gas and Water Pipes.

The question of electrolytic action due to stray currents has been brought, by the recent unfortunate decision of the House of Lords Committee in the case of the Sheffield Corporations Bill, into a position of prominence wholly out of proportion to the merits of the case. As we pointed out last week—and on previous occasions—there is not the least ground for apprehension on this score, so long as ordinary precautions are observed. To adduce American experiences as applicable to British conditions is a palpable absurdity; in America there are no regulations to be complied with, tramway undertakers carrying on their business in their own way *and taking all risks*. Now, herein lies the injustice of the new decision. The Board of Trade was authorised to make regulations for the prevention of electrolysis, but, apparently, even when these regulations are obeyed to the letter by tramway undertakers, the latter will *still* be liable for damages!

If the precautions required by the Board of Trade are inadequate for the prevention of electrolytic injury, let them be abolished altogether.

As a matter of fact, the action of the Committee implies an attack upon the efficacy of these precautions, and, therefore, upon the ability of the Board of Trade to draw up efficient regulations. Such an attack, proceeding from a committee of non-experts, and based upon mere theoretical surmise without a scrap of experimental evidence, cannot be too strongly censured. As one of our correspondents points out, the question of principle was settled as long ago as 1893 by a Joint Committee of the Lords and Commons, which heard an immense amount of evidence, and agreed upon a comprehensive clause to be inserted in all Bills and provisional orders; an extract from this clause reads as follows:—

> The exercise of the powers by this Act conferred with respect to the use of electric power, shall be subject to regulations set forth in the schedule to this Act, and to any regulations which may be added thereto, or substituted therefor, respectively, by any order which the Board of Trade may, and which they are hereby empowered to make from time to time, as or when they may think fit, for regulating the employment of insulated returns or of uninsulated metallic returns of low resistance, for preventing fusion or injurious electrolytic action of or on gas or water pipes, or other metallic pipes, structures, or substances. . . . . .

The Committee further stated that they were of opinion that it was not to the interest of the public to insist upon electrical tramways using an insulated return conductor, and that such insistence would retard the development of electric traction. And so it would.

If the gas and water companies, through the interested statements of magneticians with quite a different axe to grind (viz., at Kew) have been led to fear electrolysis under the present regulations, let them approach the Board of Trade, which is the duly constituted authority on the subject.

We repeat that the alleged danger of electrolytic injury is under existing conditions a chimera. What we really fear, with only too good grounds, is that, having obtained their clause, the gas and water companies will proceed to demand compensation for *all kinds of corrosion*, such as is constantly met with in buried pipes, and the unhappy electrica industry will be compelled to pay for sins of which it is entirely innocent. For who is to prove that a given case of corrosion is *not* due to electrolysis? The evidence of Mr. A. L. C. Fell, electrical engineer and manager of the Sheffield tramways, as to instances of corrosion prior to the advent of electric traction, shows what the Corporation may look forward to; and an interesting note, which we publish on another page, goes far in support of our contention that the new clause is a most unjust imposition upon the electrical industry. The difficulty of obtaining capital for electrical undertakings is already a heavy handicap to British enterprise; the suggestion implied by the clause, of possible heavy liabilities in the future, cannot fail to add to this burden.

Electrocution.—Our New York namesake thinks it high time that a thoroughly scientific investigation were made of the subject of electrocution as practised at certain American prisons. There is doubt as to whether the desired result is brought about instantaneously as it ought to be. Our contemporary advocates the insistence upon the appointment of a commission of experts to investigate the actual condition of the next person executed in this way, to discover if he be really dead or only in a state of coma, such as many people have experienced from severe electric shock with subsequent complete recovery. This matter is urged by our exchange in the interest of humanity, which revolts at methods of execution other than the swiftest and least painful that modern science can devise.

D

ELECTRO-MAGNETIC COILS AND PLUNGERS.

By RANKIN KENNEDY.

This simple combination, so much used in electrical appliances, has not, so far as the author can ascertain, been treated by anyone applying the modern views of magnetism thereto. Perhaps nothing better is to be found on the subject than Chapter VIII. in the book of Prof. Silvanus Thompson, "The Electro-magnet," but it does not go further than calculating the intensity of magnetic force at any point on the axis of a long solenoid, and some speculative views as to what happens with permanent magnet plungers, long plungers and short plungers, all very interesting from the point of view of the author.

Perhaps the coil and plunger can be best treated as an electro-motor, which indeed it is, even in its most elementary form. Referring to fig. 1, the coil carries a current of 10 amperes,

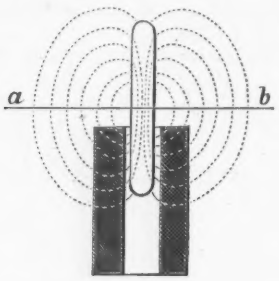


Fig. 1.

which acts on the core, producing a magnetic field as shown by the dotted curves. It is evident that the wires or conductors cut the field precisely as do they in a motor, hence the field magnet (the core or plunger) will be drawn in or the coil drawn up, the action and reaction being opposite and equal.

As the plunger of straight bar form is about the worst form of field magnet, even for a simple solenoid, it is difficult to calculate the total flux cutting the coils; but given this total flux or induction, the number of turns cut across, and the current, we can arrive at once at the pull in pounds on the plunger.

The pull on a conductor in the magnetic field of a motor is equal to

$$F = C\,B \times \cdot 00000685.$$

Where F is maximum drag on conductor in pounds per foot of length,

B = induction in C.G.S lines per square cm. cutting through the conductors.

In a common arc lamp solenoid B may, and often does, reach a value of 625; calculated by the above formula, this induction would give 0·04 lb. per foot of wire cut in the coil carrying 10 amperes.

A reference to fig. 1, however, will show that no more than half the coils of wire can be cut by the field when one half of the coil is filled by the plunger.

Let us consider different cases. Fig. 1 is a case where coil and plunger are equal in length, and we have just glanced at its magnetic condition when the plunger end is half way down the coil. In this position the distribution of the magnetic field is much as shown; one half of the flux cuts one half of the coil at right angles to the axis, and there can be found a point along the axis of the plunger where the flux is at a maximum in the plunger. This is an important point; it is shown at *a b* in fig. 1. It is a little bit below the centre of the plunger, so that when half the plunger is in the coil a few of the lines of the field will re-enter, cutting the coil in the reverse direction.

As the core, or plunger, goes down into the coil, this re-entering of the lines in the reverse direction increases until, when the plunger has reached the far end, as many lines cut the coil going out of one end of the plunger as cut it going in at the other end, so that there can be no pull one way or other, both fields being equal. This is the case of fig. 2. The coil lies in two equal and opposite fields of

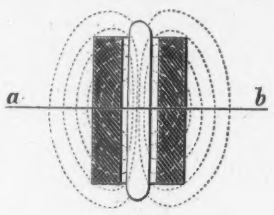


Fig. 2.

magnetic force or lines at right angles to its axis; it is this field at right angles to the axis of the coil which we must deal with in all solenoidal reactions; not the field parallel to the axis.

If the plunger is longer than the coil, it will arrive at a position of equilibrium, with ends protruding equally, as in fig. 3. The two fields of force are acting equally on the coil, and if the core is pulled steadily out we will get more and more of the one field removed from it, until a point is reached where the action of the other field is a maximum.

With a straight bar plunger and coil the field is complicated by leakage, the large air-gap allowing the lines to bend round and re-enter the core. But if we could measure the induction through the plunger at the point *a b*, fig. 4, just at the mouth of the coil, we should find this induction a maximum

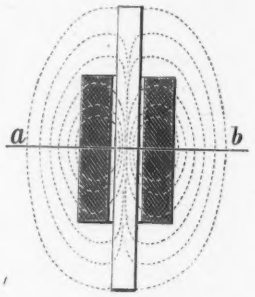


Fig. 3.

when the pull on the plunger is a maximum. When the pull on the plunger is *nil*, *i.e.*, when it is in the coil in equilibrium, the line *a b*, *i.e.*, the section of the plunger through which the induction is a maximum, coincides with the middle of the coil, as in fig. 3. As the plunger is still further pulled out its magnetism falls, and line *a*, *b*, recedes.

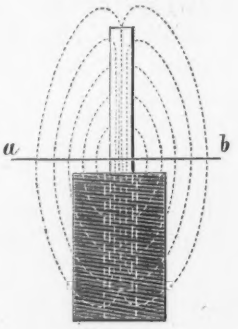


Fig. 4.

In treating of irregular cones and tubes used as plungers, this law that the sectional line of the plunger, where the induction arrives at a maximum, coincides with the middle of the coil, decides the position of the plunger when it comes into equilibrium.

Now let us consider a better field magnet for the coil. Let the core be long and bent into a horse-shoe. It is of little practical use considering the position of a core end above the middle of a coil. Fig. 5 shows a coil and horse-shoe

plunger. In this case we have the lines of force conducted round the yoke and flowing in one direction only through the sides of the coil; we have done away with one of the

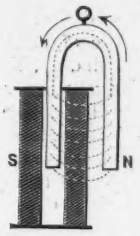


Fig. 5.

fields, and the pull goes on rapidly increasing until the core projects a little beyond the lower end. In some arc lamps each leg of the horse-shoe enters a separate coil.

The induction in the case of a horse-shoe plunger comes within more easily calculable limits. We have, say, for its maximum position, number of turns of wire in the coil × by amperes flowing = N C, and we have the sectional area and length of plungers, also approximate area and length of air-gap, from which we can arrive approximately at the value of the induction in the air-gap. This induction known, the pull can be calculated by the formula already given.

Still, a plain horse-shoe of round or flat iron produces a straggling ill-defined field of force. The polar surfaces are small, but it is a great improvement on the straight bar, where a great pull over a fairly long range is required, with small waste of energy.

Considered from these points of view, the best form of plunger and coil should be designed to make the coil wide and thin, and to use soft iron tubes inside and outside; in fact, a scientific construction of the horse-shoe type of plunger.

Here, in fig. 6, is a section of a coil, with an inner and outer soft iron tube, connected by a circular yoke, the outer tube forming a mantel over the coil.

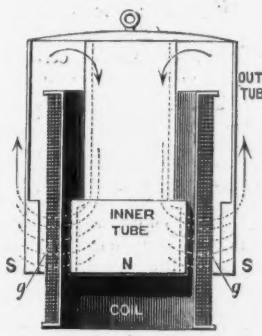


Fig. 6.

We are now coming nearer to a series-wound motor. The wires in the air-gap at g are the armature conductors, those above the air-gap the field winding; it is not necessary for me to show how easily the pull on this plunger can be calculated for any position. It may be pointed out that by making the tubes thin enough above their polar faces, they can be saturated magnetically so that the pull will be proportional to the current. This is the beginning of the higher development of the coil and plunger.

If, now, we divide the coil into two coils, one an armature, and the other a field coil, we shall be able to pull the plunger up or down by reversing the current in either half.

A further development arrives at a coil and plunger of the shunt motor type, fig. 7, a main coil forming the armature and a fine wire shunt coil forming the field winding, together with an outer and inner tube with polar faces. Here we have a constant field, and the plunger may be driven up or down according to the direction of the currents in the coils.

Another modification of the coil and plunger which is designed to give a long range of equal pull or push of small force, consists of a long solenoid with a still longer plunger. The plunger carries a magnetising coil wound in two sections, producing a pole in the middle. The sectional area of the plunger and the power of the magnetising coil must be so designed that the plunger is magnetically saturated by its own coil. A current in the long solenoid outside will pull with a long equal range either up or down, according to

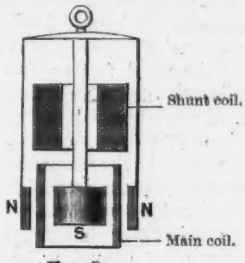


Fig. 7.

the direction of the current in the coil. In Lord Kelvin's recording instruments this coil and plunger is used; it has also been used in an arc lamp.

A very powerful coil and plunger, a modification of the foregoing one, was applied by the author to a machine for striking a heavy blow; it is sketched in fig. 8. The coil is ironclad, and has two ring-shaped inner poles, N, S, and a plunger to loosely fit the bore. This plunger has cut into it a series of grooves in which the armature winding is

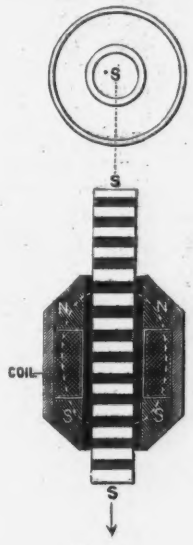


Fig. 8.

wound, to produce a pole in the middle and one at each end; the length of the core is equal to the length of the iron-clad coil plus the length of the stroke. This is a most powerful solenoid and core, or coil and plunger, and may yet be of considerable use in mechanism.

A long solenoid with two long horse-shoe permanent magnets can be used for an equable pull over a considerable range; but permanent magnets are not really permanent when acted upon for any length of time by solenoids.

Belleville Boilers.—A Plymouth correspondent of the *Pall Mall Gazette* states that the Admiralty has cancelled the order to Keyham Factory to construct 36 Belleville water-tube boilers for the cruiser *Encounter*, and has directed that the boilers shall be of the Dürr type. The *Encounter* will be the first vessel in the British Navy fitted with such boilers. The chief engineer of Keyham Dockyard will proceed to the Dürr Engineering Works, in Germany, to obtain working designs. It is also stated that it has been definitely decided to supply the battleship *Montagu* with Belleville boilers, but those of the Yarrow large tube type are to be fitted in the new battleship *Queen*.

INSULATION ON CABLES.

Mr. Mervyn O'Gorman's paper, read before the Institution of Electrical Engineers on March 7th, with the discussion thereon, is rather too long for publication here in full; we propose, therefore, to give it in abstract, together with a few notes on what appears to us to be the limits of practicability of his scheme of cable design. In a cable factory, materials cost from 10 to 18 times as much as the labour expended upon them. A factory with 150 skilled and 150 unskilled hands can turn over £300,000 worth of goods in a year, *i.e.*, £2,000 per skilled man, without complex machinery; it is therefore essential to buy with the utmost discretion, and to study the materials.

The cost of cables is the determining element in deciding for alternate or for direct currents, two-phase or three-phase working, high voltage or low voltage. In the case of a large low-tension cable conveying, say, 1,000 kw., when the dielectric has become valueless after an interval which may on the ordinary allowances for deterioration be fixed at 30 years, the value of the copper remains unaltered, say, up to 70 per cent. of the value of the cable (supposed drawn into a duct). In the case of such a high tension as 10,000 volts, however, should the cable become worthless, the amount of copper in it is too small to be reclaimed, and at the end of 30 years' life, a low tension cable is worth 50 per cent. more than its rival. A high tension cable, though a riskier thing to make than a low tension one, is more profitable, and a better advertisement.

Price lists still provide somewhat misleading schedules which show an increase of about 20 per cent. in price to correspond with a large though almost useless gain in the measured megohms per mile; whereas, whatever superiority there may be in a dearer quality of rubber, for example, is entirely dependent on the good faith of the maker, and is usually unverified by the purchaser, however scrupulously he exacts his extra megohms. Those who are ignorant on the subject must rely on the well-established maker's reputation to the detriment of new firms, however good their product and however cheap.

Searchers after cheapness turned their attention naturally to the dielectric, which was six times the price of copper, and their quest proceeded in four steps:—(1) The degrading of rubber with chalk, &c. (sometimes to excess), and vulcanising it; (2) The employment of metallic tubes, at first rigid and later flexible, these being generally lead tubes, containing cotton, jute, oiled paper, &c.; (3) The rigorous search for waterproof oils, gums, asphalte, celluloid, bitumen; (4) Discarding flexible dielectrics in favour of bare copper supported in conduits.

Process (1) is a move in the right direction; but when too much loading is given to any rubber, the latter gives way before very long, as is well known in the case of cheap garden-hose. If such an excess as this is not reached, there is still danger that the rubber may fail to envelop the particles.

The relative prices of rubber and of such hygroscopic materials are somewhat as follows:—

	£ per ton.
Para rubber	400
Congo rubber (balls)	300
Celluloid	200
Amber grease M.P. 105° F.	26
Hard grease M.P. 114—116° F.	33
Refined special cotton oil	16·25
Oxidised cotton oil (nearly solid)	26
Thick resin oil	11·25
Ordinary resin oil	6
Resin	6
Mineral oil	4·5
Pitch ... ... from £40 to	2·25
Stearine pitch (flexible)	5·15

Hydrocarbons other than rubber are mostly supported on fibrous bases, which themselves vary largely in price, and have different advantages dependent on their cellular structure. Thus:—

Good cotton (Egyptian) free from sheive	7d. per lb.
Good linen yarn unbleached	7d. „
Fine manilla paper...	5d. „
Good fine jute free from dirt and sheive	3d. „
Wood paper...	1½d. „

As regards permanency, the best materials are unsized manilla paper and fine jute. Certain dielectrics, excellent in other respects, in the course of a year develop crystalline structure, and the insulator when bent falls to powder. This is a common and more dangerous defect than is generally realised, and is often in evidence when such a cable is withdrawn from one site and laid in another.

High megohms per mile of cable are important only in feeders to facilitate fault finding, and unimportant in distributor cables and house wires where there are many terminals. The number of probable terminals per mile of distributor, or "points" per mile of house wire, settles the useful insulation by giving a measure of the weakest part of the circuit. If the allowable leakage at any exposed point, say on a porcelain block, is 10 megohms, the leakage to be allowed on the cable connecting these points might be about 10 megohms also; we are thus led to tolerate in practice a cable test of, say, 1 megohm per mile for house-wires and distributors. Such wires are quite satisfactory when a consumer's premises are supplied by a separate transformer. Ten times this might be required when the supply comes from a low-tension network; but even there the insulation need not be so good when there are only small local networks supplied by small sub-stations not interconnected. The advantage of getting such a low test admitted, is that it throws open to research, and later perhaps to practical use, a large number of otherwise impossible substances, such as celluloid, low grade acid-free pitch, clay, perhaps even some such chemical treatment as case-hardening on iron conductors, rust, oxide on aluminium conductors, &c. A further advantage of low insulation is that it diminishes the probability of high oscillating pressures when metallic switches are opened.

Experience proves that sufficient security is obtained with comparatively few megohms; large cables, say 19/16, having 50,000 megohms per mile, are now unheard of.

As the price depends upon overall diameter to an extent not usually realised, every effort must be made to find substances of which very thin films give a high puncture resistance.

Although there is a prevalent idea that cables give lower tests under high pressures, there is some doubt as to the truth of this. It would seem that the lower tests are due to increased leakages at the ends; for experiments on certain dielectric liquids have shown that they obey Ohm's law, and that their specific resistances within certain limits do not vary with the E.M.F., nor with the area of the opposed electrodes. A high E.M.F. is useful in testing, however, by tending to decompose with sufficient rapidity for detection any water in the dielectric which might escape notice with lower voltage.

Research reveals a surprising fact about our high-tension cables, namely, the large thickness of dielectric required, compared with the actual strength of the materials employed. A single strip of pure dry manilla paper, weighing 70 grammes per square metre, and about 0·003 in. thick, when tightly wrapped on a length of small wire and tightly lead-covered, will resist 1,000 volts max.; four such papers impregnated with resin and resin oil will sometimes resist as much as 12,000 alternating volts on a length of cable; and yet 20 such papers, making a thickness of 0·06 in. (an ordinary low tension radial depth), cannot by any means be expected to withstand 50,000 volts on great lengths, though on a yard length of 7/16, say, they frequently will. A suggested reason for the superior strength of the short piece is that in a 100-yard length the probability of a streak of dirt or moisture, or of metallic particles, or of the oil having been crushed out of the paper in bending the cable, or of a bubble or vacuous space, or of an irregularity in the dielectric capacity, is 100 times greater than in the 1-yard length. Indeed, except to verify the mechanical effect of severe bending, any high pressure test on a *short* length of cable proves nothing whatever about the bulk. Similarly, a test for disruptive strength on small thicknesses proves nothing about a large thickness of the same material, because a diminishing dielectric strength with increasing thickness is apparently inherent in most insulators, unless we allow that the experimenters whose results are available have made errors of remarkable similarity.

T. Gray made an interesting series of measurements on dielectric strengths, and his results, given below, may be

taken as roughly comparable, though they are open to the objections that he used large spherical surfaces, took his voltages on the primary of a step-up transformer, and assumed that a thick dielectric was reproduced by superposing a number of sheets :—

	Max. strength in kilovolts per cm.
Glass	285
Hard rubber	538
Soft rubber	476
Soft rubber (second quality)	492
Mica	2,000
Micanite	4,000
Papers paraffined—	
Manilla wrapping	430
American linen	540
Blotting felt	150
Fuller braid	295
Empire cloth	310
Empire paper	450
Lubricating oil	48
Linseed oil	83
Cotton-seed oil	67
Air 0·02 cm. between plates	57
Air 1·6 cm. between plates	27

The way to test a dielectric is on a length of cable. The area of surface of insulator under strain in a length of cable is enormously greater than in the case of a slab ; the contact between metal and dielectric is more thorough, the curve of stress is totally different, the cable material will necessarily have to be bent about and handled, and, most important, the average value of the insulator, bubbles and all, is tried, instead of a single selected square decimeter.

Bubbles are a great enemy of permanency, and tend to loss of energy, though the reason for objecting to them is not usually appreciated. If two conductors, A, C, are opposed at such a distance that the air is just able to withstand, say, 10,000 volts between them, and a strip of glass or ebonite is then introduced into the gap, the insulation breaks down, although glass and ebonite are more volt-resisting than air. The explanation is that glass and ebonite have also higher specific inductive capacity than air, consequently the potential gradient in the interposed material is less than in the narrowed air-gap ; the air in the gap, with its potential gradient steepened, is no longer able to withstand the pressure. It is clear that, by altering the potential gradient, bubbles may prove a source of weakness in cables ; uniformity of texture should therefore be aimed at in all classes of insulating materials. In present methods of the manufacture of paper cables security is obtained by choosing an impregnating oil of approximately the same S.I.C. as the paper fibre and by avoiding crumpled paper. In the case of rubber cables there should not be too great a difference between the S.I.Cs. of the materials of successive coats.

The fall of volts across an element of thickness of dielectric is greatest near the conductor and least near the outer surface ; similarly, the disruptive stress is a maximum for unit element of thickness near the conductor and diminishes from the conductor outwards. The cheapest form of cable to withstand electric stresses should therefore be one in which the dielectric strength of the dielectric in each layer is proportional to the potential gradient in that layer, at the same time having regard to the effect of difference of S.I.C. in all the layers. If the inner layers of dielectric are made of materials whose specific conductivities are greater than the average, the potential difference between the boundary surfaces of each of these layers can be proportionately reduced. Theoretically it is possible so to adjust the specific conductivities of all layers that the fall of potential through equal elements of thickness is the same throughout the whole dielectric ; or, again, substances of dissimilar S.I.Cs. might be utilised for grading the layers of dielectric to obtain uniform stress. The grading should be calculated for the probable maximum voltage.

A brief search among the available insulators shows that it is easier, without detriment to disruptive strength, to adjust conductivities than capacities by an admixture of small quantities of a less insulating substance ; but even for direct currents there is a theoretical advantage to be gained by choosing the substance with a higher specific capacity than the matrix or dielectric proper. Substances of any specific capacity immersed in a dielectric of a lower capacity tend to move slowly towards the place of steepest potential gradient. If there should remain after careful "grading" a slightly steeper potential slope near the inner conductor, for example, of a concentric cable, a tendency is thereby established which will oppose diffusion, and will help to maintain or improve the prearranged disposition if the order of both conductivities and capacities is properly chosen.

(*To be continued.*)

CURRENT SPECIFICATIONS.

LVII.—MOTHERWELL LIGHTING EXTENSIONS.

SUMMARY.

Extent of Contract.—Section A.—Supply and erection upon prepared foundations of one 180-KW. steam dynamo, together with necessary extensions to switchboard and connections between dynamo and board. Section B.—Supply and erection of necessary steam and exhaust pipes.

Type of Steam Engine.—Vertical enclosed compound engine, having, preferably, three cranks.

Specified Speed of Set.—To be maker's standard speed for this output.

Specified Steam Pressure.—150 lbs. per square inch.

Space Available for Set.—14 feet in length, width not limited.

Specified Range of Governing.—To be within 2½ per cent. on either side of normal between no load and full load, and set not to race injuriously if whole load is suddenly thrown off.

Specified Output of Dynamo.—To be capable of giving as continuous normal load 180 KW. at any pressure between 460 and 520 volts without any alteration in speed.

Specified Temperature Rise.—Not to exceed 60° F. above surrounding atmosphere for any accessible part of armature or field winding after a six hours' full load run.

Type of Shunt Resistance.—To have not less than 40 contacts, and to be suitable for controlling the E.M.F. of dynamo between 520 and 460 volts at constant speed.

Specified Tests.—A six hours' steam consumption test, to be taken both at maker's works and after erection. The steam consumption per E.H.P.-hour at full, three-quarter, and half load, to be guaranteed.

Specified Combined Efficiency of Set.—Not to be less than 85 per cent.

Specified Date of Delivery.—Six months from date of order.

Penalty for Late Completion.—One-half of 1 per cent. of each section of the contract.

Stipulation as to Removal of Foreman.—Satisfactory.

Stipulations as to Wages to be paid to Workmen.—None.

Specified Terms of Payment.—80 per cent. on delivery, 15 per cent. within one month of the taking over of the plant by the purchasers, 5 per cent. 12 months later.

Stipulated Period of Maintenance.—Twelve months from completion of work.

Amount of Security Required.—Two sureties to be bound jointly and severally in a sum equal to 15 per cent. of total contract sum.

Arbitration Proposal.—Satisfactory.

Date for Receipt of Tenders.—April 29th, 1901.

It will be remembered that Prof. Kennedy was responsible for the design of this station originally; but for this, the first extension, the Town Council are relying upon their electrical engineer, Mr. S. E. Britton, who has prepared the present specification.

The largest sized unit at present installed is 80 KW., the total capacity of the four sets being 200 KW., so that the addition of this set will practically double the available output of the station.

The specification follows well worn lines, the conditions and preferences mentioned practically narrowing the choice down to a few well known makes. It is, however, only fair to say that there are no absolutely binding clauses which cut off any chance of other types of engines being considered. The engineer has been tolerably successful in his, we believe, maiden attempt to specify ends to be attained, leaving it to contractors to determine the means to be adopted.

Tenderers are asked to give guarantees as to the steam consumptions per electrical horse-power-hour at full, three quarter and half loads they are prepared to undertake, but the wording of the clause relating to tests is a little ambiguous as to whether the engineer will insist upon full tests of the set being taken *both* at maker's works and after erection, or whether one set will suffice.

The general conditions are, on the whole, satisfactory, proceeding generally on the lines agreed upon by the Electrical Plant Manufacturers' Association and the Municipal Electrical Association. The arbitration clause,

in case of disputes, is unlimited, provided notice of appeal is given by either party within a reasonable time, and in the stipulations as to penalty for late completion, exception is made if the delay is due to strikes or combinations of workmen, or *bonâ fide* accidents to contractor's machinery.

The terms of payment may be accepted without undue risk, but tenderers should note that 15 per cent. of the contract sum is not payable until one month after the set has been taken over by the Corporation, and the last 5 per cent. till 12 months later.

CENTRAL STATION ECONOMY.—I.

Now that electricity as an agent for light and power has become an accomplished fact in this country, and the fancy prices of 6d. and 8d. a unit are no longer to be obtained, it is an imperative necessity that every possible economy should be adopted in the generation expenses, in order that electricity may be sold at prices which will compare favourably with gas and steam for lighting and power.

Coal is usually the largest item in the generation bill, and it is in this direction in which perhaps the largest saving can be made. It is not the purpose of this article to deal with very large stations fitted with the latest up-to-date methods of handling coal, mechanical stokers, &c., but rather with smaller stations which were put down before these methods came into vogue, and where the problem set before the engineer is to make the best of the plant he has without any large increase in the capital outlay.

The writer does not make any apology for speaking of matters which at first sight seem quite obvious and without need of any special comment, because in his experience it is often these obvious economies that are neglected.

Starting with the quality of the coal, one has to consider the district in which the station is situated, the boiler power available, and the relative prices of large and small coal. It is, of course, desirable that the coal should be one which does not produce a very large quantity of ash, and which does not solder on the bars. In most stations during the greater part of the year, say from March to October, the whole of the boiler plant installed is not required, and during these months a lower grade of coal at a considerably lower price can advantageously be used than is necessary in the winter months, by steaming a larger number of boilers than would be necessary if a high-class coal were being used.

The shift engineers should be encouraged to reduce as much as possible the coal burnt per unit generated, and an intelligent man can do much in this way. Firemen are apt to think that as long as they shovel the maximum of coal into their furnaces in the minimum of time they are doing well.

Attention should be paid to the manner of cleaning the fires, and the men should not be allowed to pull out a lot of live coal with their clinkers, but should be made to turn the fire over on to one side, let the clinker burn off on the other side, and then pull it out, then turn the fire into the clean side, fire up on that side, let the clinker burn off the second side, pull it out, then spread the fire, and fire up as usual. The whole operation should not take more than half an hour on a Lancashire boiler, and if carried out in an intelligent manner pressure should not fall appreciably during the process. Where there are more than one boiler at work only one should be cleaned off at a time. The intervals between the cleanings will, of course, be determined by the class of fuel and the degree to which the boiler is being pressed.

Another thing which the writer regards as being very undesirable is to leave a boiler coupled up to the steam ring with the fires banked. This is done oftener than may generally be supposed, and is attended with a considerable increase in the coal bill.

Firemen also are, as a rule, anxious to have more boilers at work than is really necessary for the load, get their boilers up to pressure long before they are wanted, and then want to couple them up to the ring "to prevent them blowing off." The shift engineer should give instructions as to the time a boiler will be required for use, and should see that his instructions are carried out.

The practice of getting a boiler up to pressure before it is wanted is not, however, nearly so bad as being late with it, and then forcing the fires so as to get up steam quickly, which, besides being wasteful of coal, is very injurious to the boilers. The writer has known of cases where a Lancashire boiler has been forced up so rapidly, that when the boiler was carrying 40 lbs. pressure, the part below the fires was cool enough to bear the hand upon. It is hardly necessary to say that very great strains are set up in the boiler under such conditions.

It will often pay to have one boiler fitted with forced draught, and in this boiler to burn up the ashes taken from the other boilers, using just enough small coal to obtain proper combustion. The whole of the heat will thus be got from the coal, and the ashes to be carted to the tip will be considerably reduced.

In most stations an economiser is installed, and care should be taken that this is cleaned out properly, and at sufficiently frequent intervals, so that the scrapers traverse the whole of the length of the tubes. The boilers themselves should be scaled, and the flues cleaned at proper intervals, and the station superintendent should himself periodically examine the boilers to see that the cleaner does his work thoroughly, and that pitting is not going on.

Where steam feed pumps are employed some economy may be obtained by passing the exhaust steam through a feed heater. A very simple and inexpensive form of heater may be made by placing a coil of piping in the feed tank and passing the exhaust steam through this, an alternative exhaust to the atmosphere being provided as well.

Another matter to which sufficient attention is often not given is the proper lagging of boilers, steam piping and valves. This is an important point, especially where superheated steam is employed, as where the piping is not properly lagged, the advantage gained by the superheat is lost by the radiation from the pipes. The valves are rather difficult to cover properly, but a removable cover made of a sheet steel case rivetted together, and packed with about 2 in. of slag wool, answers the purpose fairly well, though it is not very ornamental.

All the main steam piping should be kept in the boiler house wherever possible, only the branches coming through to the engine room.

Weekly or monthly records should be kept showing the cost of coal per unit generated.

Passing from the boiler house to the engine room, care should be taken that a proper sized unit is run for the load that is on. A small unit will usually stand a considerable overload for a short time without injury, and it will often be possible to run the day load plant for hours, loaded up to its maximum, and any sudden overload which may occur from the load rising rapidly before a larger set can be put in will do no harm.

CORRESPONDENCE.

The Institution and the Electric Supply Industry.

The electric traction industry is indebted to you for the spirited manner in which you have brought the Sheffield case before the public.

The Institution of Electrical Engineers was created for the purpose of assisting the development of the electrical industry and for safeguarding its interests. Certain gentlemen are elected as a Committee, and they are entrusted with this important duty. They do not appear to do it, and what is worse, they sometimes give expert evidence in such a manner as might lead one to imagine that the promoter's objection to the insertion of the proposed clause had not the sympathy of the Institution of Electrical Engineers.

For some years the traction industry was throttled by the Telephone Company, and had to fight against the evidence of eminent men such as Lord Kelvin, the late Dr. John

Hopkinson, Dr. Edward Hopkinson, and Sir Frederick Bramwell, who stated that the insulated return for tramways was perfectly simple, economical and reliable, and that the Telephone Company's system was an excellent one. Two of these gentlemen were afterwards called upon to construct certain electrical tramways; one tried the insulated return and failed, the other, although connected with many important undertakings, never constructed any except with an uninsulated return.

Now, the Joint Committee of 1893 settled the principle, and although the Board of Trade has absolute powers to enforce further protective measures if the present are insufficient, we find Profs. Ayrton and Perry, who have never built a tramway or electrically equipped one, who are unable to produce a single case of electrolysis from any town in which tramways are working under the existing Board of Trade regulations, influencing a Committee of laymen to grant a protective clause, thereby suggesting that the Board of Trade is incompetent to carry out the duties imposed upon it by Parliament on the recommendation of the Joint Committee.

When by the evidence of professors whose testimony is made to appear the more important to the lay mind by the use of a qualification which might suggest ability and authority to speak on behalf of an Institution, clauses are inserted in Acts which suggest unknown liabilities and endless litigation to a new and promising industry, then legislation under such conditions is a miserable farce.

One might ask, Is the industry as a body (most of them members of the Institution) going to re-elect such men to prominent positions, so that they can toy with the trust placed in them by supporting gas and water companies in their endeavour to stifle electric traction?

Everybody remembers Glasgow years ago, against the advice of those representing the industry, accepting the National Telephone Company clauses, with the result that instead of being one of the first they are one of the last to adopt electric traction, besides setting an important precedent, which had the effect of delaying the development of electric traction for some years.

This year the Electrical Trades Section of the London Chamber of Commerce, in conjunction with the Tramways and Light Railways Association, issued a warning to all tramway companies and corporations having Bills before Parliament to resist the gas and water companies' combined attack this session, and although they were offered assistance by precedent or evidence, Sheffield, like Glasgow of old, were too mulish even to respond.

What will be the eventual fate of the London County Council Act of last session and the Sheffield Bill of this? Surely these two corporations must waken to the necessity of not exercising their powers on these terms. Are they going to ask the ratepayers to provide money for constructing electric tramways under an Act suggesting an unknown liability and endless litigation?

Last session I had several petitions by gas and water companies against many schemes for protective clauses; in all cases were they refused, and yet, in spite of this, two powerful corporations make such a weak fight that a protective clause is inserted, and they have not the moral courage to withdraw their application, so as to save a dangerous precedent appearing in the statute books.

Last session the Commercial Cable Company opposed the Weston tramways to obtain a protective clause. Prof. Ayrton supported them, although a foreign company who had been refused similar protection in their own country. The argument was that the company were entitled to a clause because they had neglected to be represented before the Joint Committee in 1893, and that, although they had to protect their cables in their own country from external electrical influences, it was unreasonable to ask them to do it here.

It appears that, even on the very narrow ground of self-interest, it is essential that every electrical manufacturing company should raise its voice in protest; that the Institution of Electrical Engineers should pass a resolution condemning any change in existing legislation governing the working of electric tramways, and forward this resolution to the proper quarter; that it is the salvation of those corporations as well as companies owning or working tramways, to join forces with the Electrical Trades Section of the London Chamber of Commerce and the Tramways and Light Railways Association to protest against any alteration until (and the onus is on the gas and water companies) it has been clearly demonstrated to the Board of Trade that actual cases of electrolytic action do occur under the present conditions; if so, then the regulations can be reasonably amended, but the principle on which the Joint Committee report was founded must remain.

Stephen Sellon.

April 10th, 1901.

P.S.—Some recommendations of the Joint Committee, 1893:—

"1. The Committee, having regard to the evidence before them, are of opinion that it is not, in the present state of electrical science, to the interest of the public to insist upon electrical tramways using an insulated return conductor, and that such insistance would retard the development of electric traction."

"7. The danger from fusion or electrolytic action appears to the Committee to have arisen from a faulty system of constructing electric tramways, and they are of opinion that it can be reduced by improved methods of construction as to be practically negligible."

It is much to be regretted that Profs. Perry and Ayrton should have taken the position they did before the House of Lords on the Bill of the Sheffield Corporation. Both these gentlemen are prominently connected with colleges which have for their special object the training of electrical engineers, yet their evidence has caused a clause to be inserted in the Sheffield Corporation Tramways Bill, which, if universally enforced in other Bills, will lead to endless, and costly litigation, as well as greatly hamper and damage the progress of electric traction in Great Britain.

We have had sufficient experience since the introduction of electric tramways in this country nearly six years ago, to know that where gas and water pipes are originally in good condition, and where they are properly maintained, the rules framed by the Board of Trade are quite sufficient to prevent any damage through electrolysis. On the other hand, it is well known by all those who are practically connected with electric traction, that where pipes have been badly laid and neglected, damage due to entirely different causes may be charged to electric tramways. When an explosion or accident has once happened, sufficient evidence is not usually forthcoming to enable a true conclusion to be arrived at.

As members of the Council of the Institution of Electrical Engineers, the president and past-president should have brought the matter up before the Institution, and made suggestions by which the troubles they feared could have been overcome. If they were satisfied with the existing conditions, they should not have given evidence in favour of the gas and water companies. Experts with great practical experience and occupying a high position in the engineering world gave evidence that the gas and water companies had no reason to fear any trouble as long as their own mains were well looked after.

It is certainly to be deplored that whilst the electrical section of the Chamber of Commerce, the engineers, manufacturers, contractors, owners of tramways, and all those interested in the progress of the industry are joining together to oppose the insertion of the clause asked for in Parliament by the gas and water companies, two such well known men as Profs. Ayrton and Perry should give evidence against the industry they are supposed to represent.

There is, we fear, little reason to doubt that it was their titles as president and past-president, and not their evidence or the experience on which this evidence was founded, that induced the House of Lords to insert the obnoxious clause. It is precisely this fact which makes the matter so serious. Had the gentlemen in question only been *savants*, not connected officially with the Institution of Electrical Engineers, the matter would have been different.

Profs. Ayrton and Perry are launching every year a number of well-trained electrical engineers, yet by their evidence they are attempting to hamper the very branch of electrical engineering which at the present moment has the greatest future before it, and consequently offers the widest field for the employment of the pupils they are training.

The Institution of Electrical Engineers should take the question up seriously as to the damage which will be done to the industry in general by the clause proposed by the gas and water companies. A committee of practical men, drawn from all the branches connected with the traction industry, should be formed to work, in conjunction with the Tramways and Light Railways Association, and with the electrical section of the Chamber of Commerce, to get evidence to support those interested in electric tramway Bills against the insertion of this obnoxious clause. We might well copy the example of the Verband Deutscher Elektrotechniker, of which Mr. Gisbert Kapp is the well-known and energetic secretary. This institution is composed of professors and manufacturers, and in all cases works jointly for the mutual interest of the trade.

Something in the City.

I would like to say that I cordially agree with you in thinking that the Institution itself ought to take a more active part than it has hitherto done in helping the progress of the industry, and that it might do a vast amount of good work in this direction by making its influence felt on the Government and the Legislature.

A large portion of my contribution to the discussion on Mr. Madgen's recent paper was devoted to advocating this view.

A. A. C. Swinton.

Depreciation.

It is very kind of you to allow me to retreat under cover of "his shower of beans," but I can assure you, except for the time it might save me, I am in no way desirous of doing so, having such a good case! On the contrary, I am glad to see that *you* are beginning to take my views of the matter, viz., that a sinking fund may form part or whole of the depreciation fund, and that when you say that "I admit the whole case," I am afraid you have only casually read my letter. For instance, your statement says :—

Mr Boot admits that it is very clear that the sinking fund does not form a depreciation fund.	What I said was:—It is very clear if you (the author of the articles on depreciation) argue for ever that the sinking fund does not form a portion or a whole, as the case may be, of the depreciation fund necessary, that you will not convince the Local Government Board, who especially provided that fund for that purpose, &c.

You have evidently mistaken the *you* for myself.

I have previously sent you the full accounts and the reports of our borough accountant, and I may state definitely, that he is in strong agreement with all my correspondence to your paper, and the Tunbridge Wells accounts are certified and audited, first, by the borough accountant, and secondly, by the Local Government auditor, and the results I have given you in my tables represent *actual* facts in "hard cash"—which are beyond dispute.

Horace Boot,
Consulting and Resident Engineer.

Tunbridge Wells.

I am very much interested with regard to the question you raise in an article *re* "depreciation" in connection with Corporation electricity works, but I do not quite understand how the good people of Glasgow can have set aside 4 per cent. depreciation, seeing that the amount they have set aside for sinking fund, plus depreciation, only amounts to 1·99 per cent. on their capital averaged throughout the year, which amount would not be sufficient to pay off the capital in 25 years even allowing nothing for depreciation.

Jos. A. Jeckell.

South Shields.

[If Mr. Jeckell will refer to the paper read by Mr. W. W. Lackie (the assistant chief engineer of the Glasgow Corporation Electricity Works) before the Glasgow Local Section of the Institution of Electrical Engineers on March 23rd, 1900, he will find at page 3 the following explanation, viz. :—

"It has been the custom in Glasgow to rate and allocate this depreciation as follows :—

1. Land and buildings	1	per cent.	on	£14	0	0	=	£0	2	9
2. Machinery	7½	,,		25	0	0	=	1	17	6
3. Accumulators ...	10	,,		2	0	0	=	0	4	0
4. Mains	2½	,,		44	0	0	=	1	2	0
5. Meters	6	,,		4	0	0	=	0	4	9
6. Instruments ...	5	,,		0	18	0	=	0	0	11
7. Counting House Furniture... ...	5	,,		0	2	0	=	0	0	1
				£90	0	0		£3	12	0

"This gives an annual cost per kilowatt of £3 12s., or an average cost of just 4 per cent. on the capital.

"There is further interest on the capital at the rate of 3·1 per cent., and a sinking fund to be allowed for at the rate of 1 per cent., which together make a total of 8·1 per cent. on the capital, or a cost of £7 5s. 9d. per kilowatt of plant, no matter whether the plant is used for supplying 1 unit or 8,000 units."

Mr. Jeckell will understand that our contention is for the principle of a fund for depreciation and renewal altogether distinct from the sinking fund, which deals only with the repayment of capital borrowed and expended upon plant.

We commend the above remarks to Mr. Boot, and must now close the correspondence upon this subject.—Eds. Elec. Rev.]

Municipal Telephones.

In yours of March 29th you noted that the Brighton Corporation was asking the sister Corporation Hove to lay ducts under Hove's wood paving in case Brighton's municipal telephone scheme should some time materialise. It may interest you to know that Hove is taking the hint twice over, inasmuch as she is proceeding to lay accommodation for two systems.

The Brighton municipal trader, who is agin monopolies that are not to be in his own hands, doesn't like this, as it is reported that Hove intends before giving any lease to make certain stipulations, to wit, that Brighton shall, in case its Corporation goes into the telephone business, afford duct facilities within her own boundaries to competitors. This Brighton has steadily refused to do.

The reported attitude of Hove is a sound business one. There is no sentiment, simply the desire to secure the best conditions for a public service.

A Correspondent.

The Maintenance of Central Station Batteries.

One is always loth to adversely criticise articles appearing in the technical press, especially where such are supposed to instruct the uninitiated, but it is impossible to let the article of Mr. A. J. Abrahams on "The Maintenance of Central Station Batteries," appearing in your issue of last week, go by without remark. The scrappy pieces of advice which he gives are misleading, and are no doubt the result of the writer's limited experience in very special cases. To take only one of his last points, that a battery "should not require an overcharge of more than 40 amperes plus 10 per cent." ; surely this must refer to some battery that Mr. Abrahams has had under his care, as with a battery of, say, 150 ampere-hours capacity, this gives an ampere-hour efficiency, even after a complete discharge, of only 73 per cent., whereas a battery of 5,000 ampere-hours capacity would have an efficiency under the same conditions of over 90 per cent. This difference may, perhaps, be due to a clerical error, but seems rather to be typical of the rest of the advice.

On the much more important point of general attention to the batteries, the writer of the article has but little to say, except concerning the responsibility of the charge engineer. From experience extending over many years, I have always found that the batteries that are the best looked after are those confided to the care of an ordinary workman, who is intelligent and conscientious enough to follow closely the instructions given by the accumulator makers (which are never very complicated), but who is not intelligent enough to desire to work out theories of his own. A charge engineer who claims to have a "special knowledge," on the other hand, is often unsatisfactory; he usually considers he knows everything about accumulators and wishes to instruct the makers. He thinks himself above taking their advice or giving the few minutes daily attention required by the battery.

Perhaps you will allow me to further trespass on your space by stating what has always appeared to me the most serious neglect in the working of batteries; by far the greatest injury is done by the failure to devote regularly, every day without fail, a short time to examining the battery at the end of the charge, when not only can defects in individual cells be remedied without delay, which is the essential point, but also excessive overcharging and insufficient charging are immediately noticed. Unfortunately there is no moving part in a battery, no bearings to heat up, but its deterioration is slow, and is only noticeable after it has been going on for some time; it is consequently impossible to impress sufficiently on engineers the importance of daily attention. The rule of "putting off till to-morrow because there is something more urgent to do," reigns far too frequently; yet what engineer would withdraw all his drivers from the station while running for a reason such as this? The time required daily is short, and the expense is infinitely less than the repairs that are constantly required, because the attention is intermittent.

E. S. Jacob.

Westminster, S.W., *April 17th*, 1901.

LEGAL.

Maxwell *v.* The British Thomson-Houston Company, Limited.

This case came before Mr. Justice Kennedy in the King's Bench Division on Tuesday for further consideration. In this case Miss Agnes Maxwell, of Halton, near Leeds, sued the defendants to recover damages for personal injuries sustained through the alleged negligence of the defendants' servants. The defendants were engaged in carrying out a contract under the Leeds Corporation for the electric tramways undertaking, and the plaintiff, whilst riding on an outside seat of one of the horse trams on June 10th, 1899, was violently struck under the chin by a derrick projecting from a trolley which was standing near the tram line in Cookridge Street. The action was tried before his Lordship and a special jury at the last Leeds Assizes, and a verdict was given in favour of the plaintiff. The matter now came before his Lordship for further argument on the question of the liability of Messrs. Blackwell and Co., with whom the defendants had entered into a sub-contract to do this particular part of the work.

Mr. Scott Fox, K.C., for the third parties, pointed out that it would be idle discussing the question of his clients' liability to the defendants, seeing that there was now an appeal pending by the defendants against his Lordship's judgment.

In the result it was arranged that this question should stand over until after the appeal was disposed of.

Order accordingly.

In the Court of Appeal of the High Court of Justice on the same day, counsel applied before the Master of the Rolls and Lord Justices Vaughan Williams and Romer for leave to serve third parties with notice of defendants' appeal. He said the action was tried before Mr. Justice Kennedy at Leeds and resulted in a verdict for the plaintiff. The defendants were appealing from that verdict, and as the sub-contractors were third parties he asked for leave to serve notice of the appeal.

The Master of the Rolls: I understand you were defendants in an action, that you have been defeated, and that you want to appeal and bring the third parties here. Why cannot you do that without leave?

Counsel replied that he understood it had been decided such an application must be made.

Their Lordships granted the application.

The Finchley Urban District Council *v.* The Finchley Electric Lighting Company, Limited.

In the Chancery Division on Tuesday, before Mr. Justice Kekewich, Mr. Warrington, K.C., mentioned the case of the Finchley Urban District Council *v.* The Finchley Electric Lighting Company, Limited, which, he said, was in the paper as a motion to continue an interim order made by Mr. Justice Farwell. It had been thought advisable that the matter should be mentioned again on Friday, when he hoped terms might be arranged between his learned friend Mr. Buckmaster and himself which would dispose of the motion and of the action.

His Lordship directed the motion to stand over accordingly.

J. Gibbs & Co. *v.* Chloride Electrical Storage Syndicate, Limited.

Mr. Thomas T. Terrell, K.C., moved *ex parte* before the Court of Appeal, composed of the Master of the Rolls and Lords Justices Vaughan Williams and Romer, on Wednesday, on behalf of the defendants in this case, for a stay of execution pending an appeal from the judgment of Mr. Justice Bigham in the King's Bench Division, on the defendants bringing the amount of the plaintiffs' claim into Court, viz., £487. The learned counsel stated that the action was brought by the plaintiffs, whose registered address was the Chemical Manure Works, Cattledown, Plymouth, to recover from the defendants £487, balance of price of goods sold and delivered to the defendants, who were manufacturers and sellers of batteries for the storage of electricity. The defendants admitted the plaintiffs' claim, but alleged that owing to the plaintiffs' negligence some of the sulphuric acid supplied by the plaintiffs was of greater strength than that contracted for, and to the fact that certain carboys contained hydrochloric acid, damage was done to their batteries, and on this account they counterclaimed for £579 9s. 5d. Mr. Justice Bigham held that the defendants had failed to prove that the damage done to the batteries was due to the acid supplied by the plaintiffs, and gave judgment for the plaintiffs on the claim, and for them also on the counterclaim, but inasmuch as the plaintiffs had been guilty of a breach of contract by not delivering the acid which they undertook to deliver, he deprived them of their costs.

The Master of the Rolls: You want a stay of execution on bringing the amount of the plaintiffs' claim into Court?

Mr. Terrell: Yes.

The Master of the Rolls: When was the action tried?

Mr. Terrell: Last sitting, before Mr. Justice Bigham. Your Lordship will see that the plaintiffs are now in a position to issue execution against us. The judge ordered each party to pay their own costs.

The Master of the Rolls: An admitted debt and counterclaim for damages—you failed on your counterclaim. You admit you owe the plaintiffs money; why do you not pay them?

Mr. Terrell said that the plaintiffs were a limited company, and if the defendants paid them the money they might not be able to get it back if their appeal was successful.

The Master of the Rolls: No, no; we cannot do that. The application will be refused with costs.

BUSINESS NOTES.

Electrical Wares Exported.

Week Ending April 17th, 1900.		Week ending April 16th, 1901.	
Adelaide	Value £562	Alexandria	Value £136
Alexandria	10	Amsterdam	134
Amsterdam	175	Bombay	60
Auckland	70	Brisbane. Teleg. cable	617
Bangkok	706	Buenos Ayres	1,288
Bombay	12	,, Teleg. wire & mat.	1,402
Boulogne	35	Calcutta	282
Brisbane	115	Cape Town	827
Cape Town	37	Demerara	27
Colombo	18	Dominica	37
Copenhagen. Teleg. mat.	140	Durban	2,544
Durban	534	Gibraltar	65
Fremantle	102	Hamburg	20
Ghent	18	,, Teleg. mat.	200
Gibraltar	17	Hobart. Teleg. cable	248
Hong Kong	617	Hong Kong	87
,, Teleg. mat.	63	Malta	56
,, Teleg. stores	20	Nagasaki	107
Kobe. Teleph. cable	1,173	New Orleans	64
Melbourne	94	Otago	693
Nagasaki. Teleg. cable	20,000	Sydney	50
Penang. Submarine cable	196	,, Teleg. mat.	57
Perth	189	,, Teleph. mat.	378
Rangoon	604	Wellington	216
Rotterdam. Teleg. mat.	61		
St. Petersburg. Ships' Telegs.	450		
St. Thomas. Teleg. cable	38,000		
Singapore	85		
,, Teleg. mat.	505		
Sydney	381		
Wellington	40		
Yokohama	2,450		
Total	£67,974	Total	£9,593

Foreign Goods Transhipped.

Brisbane. Teleg. appts.	Value £211	Hamburg. Elec. goods	Value £42
		Trinidad. Elec. mat.	137
Total	£211	Total	£179

Allis's Works.—The E. P. Allis Company, of Milwaukee, whose present shops cover about 25 acres, are to erect extensive new plant, and an additional 100 acres has been purchased for the new works, which will accommodate 5,000 employés. It goes without saying that the site procured is specially well situated for railway and like facilities, and that the equipment will be of the most modern and efficient character so far as economical production is concerned. Over 40 electric cranes will be employed for serving the shops and intervening storage spaces. A plan of the works recently appeared in the *Street Railway Review* of Chicago.

Austria.—The Electricitäts Gesellschaft (Kolben & Co.), of Prague, has declared a dividend of 5 per cent. for last year.

Blast Furnace Gases in Austria.—Messrs. Breitfeld, Danek & Co., of Carolinenthal, Prague, Austria, are at present engaged on the construction of a four-cylinder gas engine of 600 H.P., to be operated directly by the waste gases of blast furnaces. It is intended for the Kladno Ironworks, where it will be directly coupled to a 600-H.P. alternator, built by Messrs. Kolben and Co., of Prague.

Books Received.—"Fire Tests with Doors." No. 60. London: The British Fire Prevention Committee, 1901. 2s. 6d.

"Annual Report of the Smithsonian Institution, 1898." Washington.

"The Economical Disposal of Towns Refuse," by W. F. Goodrich. London: P. S. King & Son. 10s. 6d. net.

"Guide to the Search Department of the Patent Office Library, 1901." London: The Patent Office. 6d.

Buffoline Noiseless Gears.—The Buffoline Noiseless Gear Company, of Levenshulme, inform us that they will have a number of gears running at the coming Glasgow Exhibition. Information required regarding them may be obtained from Mr. T. L. Davidson, 49, Jamaica Street, Glasgow, or direct from the works at Levenshulme.

Catalogues and Lists.—The British Uralite Company, Limited, of Lombard Street, E.C., is issuing a circular describing its speciality, "Uralite," which is a fireproof and non-conducting material for building and other work. It is being shown for the first time in England, at the Building Trades Exhibition at the Agricultural Hall this month.

From Ing. C. Olivetti, of Ivrea, "Fabbrica di Istrumenti Electtrici," we have received an illustrated pamphlet relating to his electrical measuring and other scientific instruments.

Messrs. E. F. Moy, Limited, have issued Sheet No. 48, which relates to double-pole knife switches in cast-iron cases.

Two new circulars have been published by the Westinghouse Company. No. 1,042 is taken up with multipolar generators and motors of the belted type for direct current lighting and power. No. 1,043 describes generators and rotary converters for electrolytic work.

Messrs. Young & Marten send us several lists relating to their electrical specialities, such as high voltage "loop-in" ceiling rose for direct wiring, casing and capping, the "Caledonian" electric shop window lamp; also a leaflet detailing a variety of electric light fittings and accessories of a general kind.

The Hart Accumulator Company, Limited, of Stratford, has brought out a handy-sized pocket edition of its price list of the Hart storage batteries, which have been, and are being, supplied to many public authorities throughout the kingdom.

The Schattner Electricity Meter Company, Limited, of Islington, send us a copy of a new booklet describing their meters, and containing some comments relating to the respective advantages of the different systems. Electricity meters are classified and briefly detailed, more particularly the Long-Schattner form of prepayment meter with which our readers are familiar, it having been fully discussed in the columns of the ELECTRICAL REVIEW. The prepayment and standard recording meters are technically described with the aid of diagrammatic and other illustrations, and copies of expert reports accompany the descriptions.

The Brush Electrical Engineering Company, Limited, has brought out an excellently printed "Brush Electric Traction Catalogue." The important position occupied by the company in respect to the carrying out of complete electric tramway equipments from start to finish, is well known to our readers, and in the publication now before us the machinery, apparatus, trucks, and cars with which they do such work, are set out in a convenient and attractive manner. Steam dynamos and alternators, various types of traction motors and controllers, single, maximum, and bogie trucks, single and double-decker cars, also vestibule and open cars, and railway cars such as they have furnished for the Central London Railway are included.

Dissolutions and Liquidations.—The New British Incandescent Electric Lamp Company has resolved to wind up voluntarily, with Mr. E. C. Moore, of 3, Crosby Square, E.C., as liquidator.

A meeting of the Printing Telegraph Recorder Company will be held on May 13th, at 13, Basinghall Street, E.C., to hear an account of the winding-up from Mr. G. A. G. Robertson, the liquidator.

Creditors of the Electrical Vehicle Syndicate are asked to send particulars of debts, &c., to Mr. A. Holmes, Portland Road, Newcastle-on-Tyne, liquidator, by May 31st.

Messrs. Glyn, Mills, Currie & Co. on Wednesday presented a petition before Mr. Justice Wright in the Companies' Winding-up Court for the compulsory winding up of the River Plate Electric Light and Traction Company, Limited. Mr. Eve, K.C., said he appeared for the respondent company. The matter had been standing over for a very long time, and he understood that the petitioners were satisfied that the only chance of getting anything for the unsecured creditors was that an arrangement should be made to sell out the undertaking in Argentina; he was content that the matter should stand over generally on the terms that if any proceedings were taken in the debenture holders' action the petitioners should have notice of them. This course was agreed to, and his Lordship said he would make no order as to costs.

The petition of Mr. Adam Scott for the compulsory winding-up of the National Company for the Distribution of Electricity by Secondary Generators, Limited, was before Mr. Justice Wright in the Companies' Winding-Up Court on Wednesday. Mr. Scott, the petitioner, appeared in person, and said the grounds for the petition were that there were circumstances which required such a strict examination as could only be obtained under a compulsory order. He had filed an affidavit which went into the history of the company extending over 16 years. He represented shareholders to the extent of £68,000, and he himself had £1,000 in shares. Mr. Gore Brown was understood to say that Mr. Scott had only paid £5 or £10 for his shares. Mr. Scott, proceeding, said he wanted the company wound-up in order that it should be made to contribute to the shareholders some of their lost money, and that some inquiry should be made into the acts of the directors and others concerned. There were allegations against the directors and promoters of conspiracy to defraud in connection with the French patents and other foreign rights. It was only, he contended, under a compulsory liquidation that a proper investigation could be made. Mr. Erle said he appeared for Madame Ruel, a creditor, and shareholders to the extent of £40,000. Mr. Gore Brown said there was a cross action against Madame Ruel for £200,000. Mr. Scott handed in a list of those supporting the petition. It was headed by Sir Geo. Elliot, Bart. Mr. Gore Brown said that had not been filed, and he knew nothing about it. There was litigation pending with regard to the patents. His Lordship said he had read the affidavit of the petitioner, and there was sufficient ground for winding-up the company because it was, in fact, at present winding itself up. The only question was whether there were grounds for a compulsory order. The voluntary liquidation had been going on for two years, and if he dismissed the petition, Mr. Scott would not be deprived of any remedy he might have against the directors for misconduct or misfeasance. At present he did not see sufficient grounds on the petition of one shareholder who was said to have given only £5 for 1,000 shares for making an order, and he dismissed the petition with costs.

The petition of Messrs. Ede and Allom for the compulsory winding-up of the British Electrozone Corporation, Limited, was before Mr. Justice Wright in the Companies' Winding-up Court on Wednesday. Counsel for the petitioners said he had received no notice of opposition, but he had just received an affidavit which required answering, and he asked for an adjournment for a week. It was a case in which there had already been a voluntary winding-up, and there was a question of bonus shares having been issued. His Lordship allowed the petition to stand over as requested.

Electric Blowing at Lincoln Cathedral.—The bellows of the new organ of Lincoln Cathedral, which is one of the largest cathedral organs in the country, have for over two years been driven by electric motors. The (230-volt continuous) current is supplied by the Corporation, and so far this is the only instance of the city supply being used for power by private consumers, owing probably to the refusal of the Corporation to supply current for motors at a smaller cost than for lighting purposes. The organ, which was erected two and a half years ago by Messrs. Willis and Sons, has four manuals, about 70 stops, and a pneumatic action, so that a great amount of wind is required, especially for the pedal organ. There are three bellows—heavy, medium and light pressure—having weights upon them respectively, 3 tons, 2 tons 14 cwt., and 1½ tons. At the first installation there were motors of 3, 1½, and 1 H.P., but for various reasons considerable alterations have been made, and now by an arrangement of Messrs. Willis's patent rolling pallet the medium pressure bellows can receive wind from the heavy pressure and the light pressure from the medium pressure bellows, so that only two motors are required, of respectively 2 and 1½ H.P.; an ample supply of wind is secured, and what is a great advantage in such a building, this is done quite noiselessly. The cost of energy per hour has been reduced from 1s. 9d. to a trifle over 8d. The starting switch is in the organ loft, and is actuated by the organist or his assistant. The motors are connected with circular regulating switches, which, by means of straps, divert the current to galvanised iron wire resistances when the bellows are full. For tuning, &c., enough wind is supplied by one motor. Messrs. Laurence, Scott & Co., of Norwich, built the motors, which are enclosed, series wound, and low speed. The whole apparatus is attended to by two gentlemen, members of the congregation. Various parts of the cathedral are lighted by electricity; at the present time an experiment, which bids fair to be successful, is being made of lighting up the choir with this illuminant, and in a short time we may expect to see electric light adopted in all parts of this beautiful and historic building.

Electric Pumping.—A Newcastle paper says that Messrs. Ernest Scott & Mountain, Limited, have secured a contract from the South Durham Coal and Iron Company for their Eldon Colliery, for what will be the largest electric pumping plant in the district. The plant will consist of a compound horizontal engine of 450 H.P., with generator of 250 KW. capacity, the electromotive force at the terminals being 560 volts. The generating plant will be situated at one of the company's pits, about 800 yards from the pit at which the pumping is required, and the current will be conveyed overhead by conductors on poles. It will then be taken down the shaft by heavily armoured cables to two sets of three-throw horizontal pumps, each set of pumps delivering 500 gallons per minute, or collectively 1,000 gallons, against a head of 400 ft. Each of the pumps will be driven by one Tyne motor of 120

effective H.P. by means of cotton ropes, it being found that an elastic medium, such as ropes or belts, is an advantage between pumps and motors, as it takes off the shock when working under heavy heads.

Electrical Import Charges in Sweden.—A proposal is at present receiving the consideration of the Swedish Parliament that the import duty on electrical machinery should be increased from 10 to 20 per cent. *ad valorem*. Owing to the utilisation of the many waterfalls, a large amount of such plant has been imported in recent years, particularly from Germany. There is only one large electrical engineering concern in the country, although another one is projected. It is not considered probable that the proposed increase will be adopted, there being a strong feeling that it is yet too early to attempt to keep foreign electrical plant out of Sweden.

The Electrical Outlook in India.—There are unmistakeable signs that American electrical manufacturers and suppliers intend to leave no stone unturned to capture a large share of the electrical business of India. Already they have left their impress upon certain schemes, and they are keeping themselves well alive to what is taking place. An American exchange summarises the present position of electrical development there in the following terms:—"The larger Indian cities are taking up questions of local lighting and trolley traction, and a good market bids fair to spring up. The fact that American apparatus has been ordered for the Mysore transmission is said to be only an indication of readiness to buy apparatus here. United States Consul-General Patterson, of Calcutta, has recently made an interesting report on the subject, which is supplemented and confirmed by advice from a correspondent of the New York *Electrical World*. He states that the past year has been marked by a great development of electrical enterprise in India. The largest scheme is that at Mysore, where the waters of the Cauvery Falls are being harnessed for the benefit of the gold mines. In Calcutta, the tramways company will shortly adopt electrical traction, and will require dynamos of the same size as those ordered for Mysore; but there is no water-power available in Calcutta, no one as yet having essayed to chain the mighty Hooghly. But the largest dynamos yet ordered for India are those for the Calcutta Electric Supply Corporation, whose engineer, Scott Moncrieff, has just returned from England, having arranged for the delivery of two sets of engines and dynamos, each of 1,100 H.P. The electric fan, driven by current from the corporation's mains, has already acquired great popularity in Calcutta. These fans are in most cases placed 15 ft. apart. In the cathedral, which is pronounced the coolest place in Calcutta in the hot weather, they are placed 10 ft. apart. The central telegraph office and the High Court have adopted the 15-ft. standard, and private installations vary in their number of fans according to the ideas and pecuniary resources of the householders. The Electric Supply Corporation has introduced a system of hiring out fans at a charge of 4 rupees ($1.28) per month for each fan, which is likely to prove popular. The electric light is also particularly useful in India, and its widespread use in Calcutta shows how well it is appreciated. In addition to the above instances of the use of electricity, it is announced the workshops of the East Indian Railway and of the Bengal-Nagpore Railway will shortly be driven by electricity, the shafting, belts and pulleys giving place to electric motors.

Fire.—On Friday last an outbreak of fire occurred in the packing department of the new and extensive works of the London Electrical Fittings Company, Limited, in the Hampstead Road. The firm's employés, with the fire appliances at hand, managed to extinguish the flames before the arrival of the fire brigade. The plant or stock was not damaged, and no delay whatever will occur in the execution of orders.

Fire Prevention.—The British Fire Prevention Committee's new testing station at Westbourne Park is to be opened during the month. There is a Fire Prevention Section at the Building Trades' Exhibition now running at the Agricultural Hall. The exhibits occupy the Minor Hall.

French Trade in Electrical Machinery.—From the official statistical returns for the year 1900, just published by the French Government, the *Electrical World* gathers that France imported during that year dynamo-mechanical machinery to the value of 11,963,250 francs, as against 6,018,473 francs in 1899, and 3,740,562 francs in 1898. Parts of electrical machinery were imported to the value of 4,348,160 francs, as compared with 2,080,760 and 1,569,651 francs in 1899 and 1898, respectively. The imports of electric accumulators represented a value of 64,650 francs 1900, as against 101,859 francs in 1899 and 136,691 francs in 1898. Incandescent lamps were imported to the value of 480,000 francs in 1900, 506,440 francs in 1899, and 479,040 francs in 1898. It will be seen from these figures that the total imports of electrical machinery and incandescent lamps amounted in value to 16,856,060 francs in 1900; 8,597,532 francs in 1899; and 5,926,004 francs in 1898. The great increase in the imports of 1900 is largely to be traced to the demand for machinery created by the Exposition. The exports of electric machinery from France are relatively small. The principal figures for 1900 and 1899 and 1898 are as follows:—Dynamo machinery, francs, 1,647,720, 2,074,754 and 1,434,873; parts of electrical machinery, francs, 2,079,000, 1,991,736 and 2,250,315. The statistics above referred to are but a *résumé* of the foreign trade of France and details on the exports and imports as to the countries of origin, &c., are not yet available.

Imports of Foreign Electrical Plant.—A steady increase appears to be taking place in the importation of foreign electrical plant and apparatus into this country. The returns just issued set the value of such imports during March last at £130,076, as against only £97,296 in the preceding month, and £73,085 in March last year. For the first quarter of the current year, the value of the imports has attained a total of no less than £321,689, as contrasted with only £197,018 in the first three months of 1900.

Personal.—Mr. Ernest Kilburn Scott, M.I.E.E., A.M.I.C.E., has taken up the position of engineer and manager (United Kingdom, Colonies, and Egypt) to the International Electric Company, of Liège, the London offices being at Clun House, Surrey Street, Strand, W.C. Besides the ordinary run of electric lighting work, Mr. Scott proposes to give special attention to the application of continuous and polyphase motors to machine driving in factories, iron and steel works, &c., also to mining work, electric traction for tramways and railways, and to long-distance power transmission. The International Electric Company, of Liège, is the most important electrical concern in Belgium, and was founded in 1889 by Mr. Henry Pieper, general director. The manager and technical director, Mr. G. J. Melms, was with the General Electric Company, of America, for many years, and as manager for Messrs. Brown, Boveri & Co., Frankfort, personally supervised the construction and operation of the Frankfort municipal electric station—one of the largest central power stations in Europe, having a single-phase motor load of upwards of 6,000 H.P., including three motors of 750 H.P. for working the city tramways. Under Mr. Melms's management, the International Electric Company, of Liège, have of late years taken a prominent position in the electrical world, having created many new and special forms and types of electrical machines. Amongst others, the company have supplied machinery to a number of large firms in the United Kingdom, including Messrs. Sir Christopher Furness, Westgarth & Co., Limited, Sir Raylton Dixon & Co., Limited, Wilson, Pease & Co., Limited, Dorman, Long & Co., and other firms at Middlesbrough, Messrs. Wm. Gray & Co., Limited, Furness, Withy & Co., Limited, and the Irvines Shipbuilding and Dry Docks Company, Limited, at Hartlepool, and various others at Sunderland, Dumbarton, Glasgow, Belfast, and in South Wales. Mr. Scott, whose name is familiar to all readers of the ELECTRICAL REVIEW, has our best wishes for success in his new sphere of labour.

Scottish Contractors' Association.—We have received a copy of the "Constitution of the Association, Rules for Men, Manufacturers, Consulting Engineers, and Architects," of the Scottish Electrical Contractors' Association (Glasgow centre). The objects of the Association are "to discuss questions affecting the general interests of the trade and to promote uniformity of action or practice regarding these." One of the objects of special moment to manufacturers is stated thus:—

> Whereas electrical contractors have frequently suffered by the action of some manufacturers and wholesale dealers in electrical plant, material, and fittings, who take advantage of the position secured to them by the support of the electrical trade, to deal direct with consumers to the detriment of contractors, this Association recommends its members to give preference in their orders to those manufacturers and dealers who are most free from such practices. With a view to guiding the General Committee for future combined action, this Association invites its members to record, and send to the secretary, particulars of all cases where the circumstances seem to suggest that consumers may be receiving full or partial trade discounts, either directly or through consulting engineers or architects.

Mr. Thomas Wright is president of the Association, and Mr. J. M. Davies, jun., of 168, St. Vincent Street, Glasgow, is the secretary.

Still Motors.—Messrs. Shippey Bros., Limited, who have been appointed sole British agents for the Canadian Electric Vehicle Company, the owners of the Still electric system, have received their first shipment of the new type of vehicles which are described in the list now being circulated. We understand that arrangements have been completed for the construction of the vehicles in England. The pamphlet now before us illustrates some neat designs of "Victoria," dog-cart, runabout motet, also views of delivery wagons and other electromobiles. Messrs. Shippey have also been appointed sole European agents for the sale of the new standard "Milwaukee" steam cars, steam wagons and other engineering specialties as manufactured by the Milwaukee Automobile Company. It is stated that as soon as financial arrangements have been completed, branch sale depôts will be opened in Paris, Brussels, Berlin, Amsterdam, Lisbon and other approved Continental cities for the sale of the "Milwaukee" steam cars which will be sold in combination with the Canadian Electric Vehicle Company's ideal storage battery, and the "Still" electric vehicles, carriage motors, controllers and gearings as now manufactured in England under royalty.

Trade Announcements.—The increased business of Callender's Cable and Construction Company, Limited, has necessitated their removing to larger offices. On and after April 16th their address will be Hamilton House, Victoria Embankment, E.C.

The Sun Fan Company has changed its London office to 6A, Billiter Buildings, Leadenhall Street, E.C., and has opened a new office at 82 and 83, Deansgate Arcade, Manchester. Mr. G. C. Fuller, who has been for many years representative and electrical specialist for the Blackman Ventilating Company in London and the South of England, has joined the Sun Company's staff in a similar capacity.

The Testing Station of the British Fire Prevention Committee has changed its location from North Bank, Regent's Park, to Westbourne Lodge, 66, Porchester Road, Bayswater, W., to which address communications for the resident engineer should be sent.

We understand that the Standard insulating varnish, made by the Standard Varnish Works, of New York, and referred to in our advertisement this week, has attained a high reputation in the United States, the Continent, and also in England, for its great

elasticity and high-insulating properties. Mr. Dolph, the expert who is in charge of their Insulating Varnish Department, will shortly arrive from the States, when he will be at the command of clients.

We have received notification from Brisbane to the effect that owing to continued confusion that has arisen in respect of the name the Electric Construction Company, Limited, has reverted to its original name, Trackson Bros., Limited.

Messrs. Pinching & Walton, of 1, Crutched Friars, E.C., have removed to 52, Cannon Street, E.C.

ELECTRIC LIGHT AND POWER NOTES.

Abertillery.—The B. of T. has granted a prov. order for electric lighting.

Barnsley.—The accounts of the electric light department for the first year show a small surplus of £8. The Council has resolved that Mr. Barstow, the electrical engineer, be engaged for a further period of three years, at a salary for the first year of £300, second year £350, and third year £400.

Belgium.—The "C" central station of the Brussels municipal electric lighting undertaking is about to be enlarged.

Bradford.—In reference to the Yorkshire Electric Power Bill, the Bradford Corporation, after consideration of the amended clauses submitted by the company, has decided not to take any action otherwise than in conjunction with Sheffield and Leeds, who are opposing jointly with Bradford. The town clerk has been instructed to require from the promoters of this and the South Yorks Electric Power Bill, a suitable clause with respect to the prevention of electrolytic action on gas and water mains, and to oppose in the House of Commons if such a clause is not conceded.

Dorking.—The U.D.C. has adopted an agreement as to the transfer of its prov. order to the West London Electric Supply Company, Limited, providing amongst other provisions that Messrs. Johnson & Phillips's plant be utilised, free wiring be provided, and that legal costs, not exceeding £500, be paid by the company.

Fakenham.—The Parish Council has obtained a report from Mr. E. H. Cozens-Hardy on the electric lighting of the town, and has accepted the tender of Messrs. Fryer for laying cables, &c., at £592 10s. The electricity supply is to be obtained from Messrs. Miller, Son & Co., of Fakenham, at about 5d. per unit.

France.—The Municipal Council of Port-Sainte-Marie, Lot et Garonne, has accorded the concession of the private and public lighting of the town to M. Fourès, contractor. The work of construction of a new central power station is to be commenced immediately. The Municipal Council of St. Martin-les-Boulogne, Pas de Calais, has accorded a concession for a period of 40 years of the electric lighting of the commune to Messrs. Maurice Lonquty and Félix Adam. The cost of public lighting will be 60 centimes per KW.-hour and of private lighting 80 centimes.

A project is at present on foot for the installation of a central power station in the town of Roubaix, France. The scheme stipulates for overhead conductors, and power would be furnished for both public and private lighting as well as for motive power. The French Marine will shortly place orders for the material necessary for the installation of two electric power stations in connection with the arsenal of Bizerte.

Glasgow.—There has been a good deal of copper wire and lead — the property of the Corporation, and of the National Conduit Company—stolen during the past two months, and an offender was brought before the Northern Police Court on 8th inst. charged with the offence.

Greenock.—Under the new prov. order to be obtained by the burgh it is proposed to obtain powers to supply energy in bulk to the neighbouring burgh of Gourock.

Halifax.—The T.C. last week fixed the price of electricity for lighting purposes at 4d. per unit to consumers of under 7,500 units per quarter, and 3d. per unit beyond that quantity; also for power purposes at 2d. per unit. The Electricity Committee had been charging the Tramways Committee 2½d. per unit, and Alderman Woodhead asked how they could sell at 2d., when, a short time ago, they declared that the lowest price at which they could supply the tramway energy was 2½d. Mr. J. H. L. Baldwin, chairman of the Electricity Committee, said the depreciation on the tramway generating plant was greater than on the electric lighting plant, and that the total cost of the generation of both sorts of electricity was about 2·23d. per unit, so that the Tramways Committee were supplied below cost.

At the New Poor-Law Hospital, erected at a cost of £100,000, there are six ward lifts, each capable of holding a hand ambulance patient and three other persons, and two service lifts for coal, dinner wagons, boxes, &c., all worked by electricity generated on the premises at 110 volts. Careful tests on the lifts show that one unit of electricity is sufficient for 84 round trips of the large lifts. The gearing consists of a hardened steel worm, coupled direct to the electric motor, which is entirely enclosed, and gearing with a machine-cut gun-metal worm wheel running in an oil bath. The rate at which the current is switched on to the motor is quite independent of any action on the part of the lift attendant, and is entirely automatic.

Hampton.—The U.D.C. has invited the London United Tramways Company to submit terms for the supply of current for lighting the district.

Hendon.—In reply to the request for an extension of time for three years, the B. of T. will not allow more than 12 months from May 17th next for the completion of the electricity works.

Heywood.—The L.G.B. has sanctioned the application of the Corporation for a loan of £15,000 for electric lighting purposes. Mr. W. S. Johnson, of Sheffield, has been appointed clerk of works in connection with the electricity works.

Hoylake.—The U.D.C has resolved to apply to the L.G.B. for leave to borrow £12,000 for electric lighting purposes.

King's Lynn.—On Wednesday last week the Mayor formally started the new plant which the Corporation has laid down to cope with the increasing demand for energy. The extensions, for which a loan of £10,000 has been sanctioned, consist of two dynamos of 120 and 200 KW. respectively, each designed for a maximum pressure of 500 volts, coupled direct to vertical high speed engines. The dynamos were supplied by Messrs. Laurence, Scott and Co., Limited, of Norwich; the engines by Messrs. Belliss and Morcom, Limited; the boiler, economiser, &c., by Messrs. Yates and Thom, of Blackburn, the whole of the extensions being carried out under the supervision of the resident engineer, Mr. J. Pilling.

Kingston-on-Thames.—The Corporation, on an estimated demand for 90,000 units per annum at the Workhouse, has quoted 4½d. per unit all round, which would amount to £1,687 10s., as compared with £857, the estimated cost of gas lighting. It is now proposed that the Guardians should slightly extend the proposed boiler accommodation at their new premises, and spend some £4,000 for electric lighting plant. Under this scheme the working expenses and interest would work out at £792 14s. per annum, or less than the cost of gas.

Kirkcaldy.—The Secretary for Scotland has given his consent for the borrowing of £50,000 in connection with electric lighting. This sanction is not required in the case of the tramways. Both schemes will be advanced simultaneously.

Leith.—The T.C. has resolved that the price of electrical energy be reduced from 5d. to 4d. per unit, with the same discount as at present, for lighting purposes.

Linlithgow.—Messrs. Crompton & Co., Limited, through their Edinburgh representative, Mr. Purves, have advised the T.C. that they are willing to undertake the lighting of the town, and to get a prov. order themselves. If the local authority gets the order, they are still prepared to take over the undertaking, and supply current at the rate of 6d. per unit for lighting and 3d. per unit for cooking and power purposes.

London.—ST. MARYLEBONE.—A special report has been issued by the Board of Trade under Section 1 of the Electric Lighting Act, 1888, in reference to electric lighting in the borough of St. Marylebone. It states (says the *Times*) that in 1889 the Metropolitan Electric Supply Company, Limited, obtained an order giving them electric lighting powers in the parish of St. Marylebone. In the same year the Board of Trade adopted the policy, as regards the metropolis, of granting powers to two bodies in respect of the same area, and this policy has been confirmed by Parliament in respect of several parts of the metropolis. In 1898 the Board refused the applications of two companies for provisional orders in respect of the parish, but granted an order to the Vestry. The Metropolitan Company opposed the confirmation of the order on the ground that competition by the Vestry would be rate-aided and consequently unfair, and the House of Commons refused to confirm the order. During 1899 numerous complaints were received by the Board of Trade from consumers in the parish as to interruptions in the supply given by the Metropolitan Company, and the necessity was then urged for a competitive supply. In 1900 the Marylebone Electric Supply Company, Limited, one of the companies which applied in 1898, applied again for an order. The application was opposed by the Vestry, but the Board of Trade, having regard to all the circumstances, decided to dispense with their consent and granted the order. The Bill to confirm the order, however, was rejected on second reading in the House of Commons. In the course of the debate representations were made that the Vestry were in negotiation for the purchase of the Metropolitan Company's undertaking in the parish, but the Vestry subsequently decided not to proceed with the negotiations. This Session the Borough Council of St. Marylebone (who have succeeded the Vestry) and the Marylebone Company have both applied for orders in respect of the parish (now the borough). The Borough Council (as local authority under the Electric Lighting Acts) have refused their consent to the company's application, but the Board of Trade have decided to dispense with the Council's consent and have granted the order, and also the order applied for by the Borough Council, with the view of giving Parliament the opportunity of deciding on the question as a whole whether any, and, if so, what supply of electricity in St. Marylebone should be authorised in competition with the supply given by the Metropolitan Company.

SHOREDITCH.—The Borough Council on Tuesday received a letter from Messrs. Aublet, Harry & Co., Limited, in relation to the Council's wiring department. A few weeks ago the company informed the Council of two instances which had come under their notice of competition on the part of the Council's wiring branch. In the first place the company tendered for a contract and found that the successful competitor was the Council, whose price, the letter stated, was 50 per cent. lower than that of the company. The

latter contended that if the work was carried out at cost price it could not be done for the amount of the accepted tender, and that the competition of the Council with local firms was unfair. The company submitted that the Council was exceeding its powers in undertaking the work.

The Lighting Committee, at a meeting of the Council on the 2nd inst., reported that the statements in the letter were not correct.

At Tuesday's meeting of the Council a further letter from the company was read, pressing for a reply to a question as to the authority of the Council to become contractors. The letter was referred to the Lighting Committee for consideration.

Stepney.—The Borough Council is to apply to the L.C.C. for sanction to a loan of £34,670, the balance of a loan of £105,170 applied for by the late Whitechapel District Board of Works.

Macclesfield and Widnes.—The B. of T. has sanctioned a prov. order for the electric lighting of the borough.

Newport.—The Electricity and Tramways Committee reports on the question of the future development of the electricity undertaking, by Mr. R. Hammond, consulting engineer, and the borough electrical engineer, have been received by the Borough Council.

At a meeting of the Electricity and Tramways Committee, the payment of £8,000 to Lord Tredegar was ordered in purchase of the site of the generating station.

The new Corporation Road tramline is now complete. It is to be worked by electricity, but pending the construction of a new power station, horse haulage will have to be used. The borough engineer has been instructed to prepare a scheme for extensions of the tramways.

Oldham.—The Corporation has received permission from the L.G.B. to borrow £156,510 for the new generating station at Greenhill.

Paisley.—The electric lighting accounts for the year ending December last, show a deficiency of £4,723, which will be provided for from the funds of the Gas Corporation.

Perth.—The opening of the electricity works has been provisionally fixed for May 4th. Some of the principal shopkeepers in the High Street have grown tired of waiting, and have put down installations of their own, with very successful results.

Richmond.—The T.C. has decided to take legal action in the event of the Richmond E. L. Company proceeding to violate their contract with the Corporation by continuing with their scheme to supply current for the Heston and Isleworth district.

Rochester and Chatham.—It seems a great pity that all the local authorities of Rochester, Chatham, and New Brompton cannot agree in consenting to take over the several undertakings of the Chatham, &c., Electric Lighting Company, in their respective districts. The Gillingham D.C. (New Brompton), the youngest authority by far in the whole district, having decided to purchase the New Brompton undertaking of the company, has appointed Mr. W. H. Trentham as valuer. The Council has also decided to purchase ground attached to the works, as it expects the scheme to grow immensely, and New Brompton is increasing by leaps and bounds.

At the Chatham Council meeting last week the Committee further considered the proposal to purchase the Chatham portion of the E.L. Company's works, and a letter was read from the company's solicitors, asking the sum of £35,000 for the purchase. It was resolved that the provisional offer of £20,000 made by the Corporation be not confirmed.

Seaford.—The B. of T. has extended the prov. order to June 30th, and a syndicate has accepted the terms offered by the Council for the transfer of the order.

Spain.—A company has just been formed in Carthagena with the title La Compania de Alumbrado y Fuerza Electrica "Hispania," to establish a large central power station to generate and supply electrical energy for lighting and power purposes to the mining undertakings in the Carthagena and La Union districts.

Stourport.—The U.D.C. is considering the question of lighting the town with electricity.

Sweden.—The "Bergvik-Ala nya Aktiebolag," of Bergvik, Sweden, projects the establishment in the Norrland, Sweden, of a new sulphite factory, the motive power for which would be supplied by electric energy developed by a waterfall in the neighbourhood. The electric installation will cost £17,000, and the total installation £127,000. The factory will turn out 15,000 tons of sulphite annually. The Electric Power Company, of Trollhättan, Sweden, has a project under consideration for the utilisation of a waterfall situated on the Lule, for the development of electric energy.

Teddington.—The U.D.C. has referred to the newly constituted E.L. Committee the offer of the London United Tramways to supply current for lighting purposes at a maximum charge of 4d. per B.T.U.

Wallasey.—Last week Col. F. J. Marsh held a public inquiry on behalf of the L.G.B. into an application made by the U.D.C., for permission to borrow £12,500 for extending the electric lighting system.

Walsall.—Colonel W. Langton Coke held an inquiry on behalf of the L.G.B. last week, respecting an application made by the Corporation for sanction to borrow £3,000 for electric lighting. There was no opposition.

Wolverhampton.—The L.G.B. has granted the application of the T.C. for leave to borrow £58,942 for electricity supply.

ELECTRIC TRACTION NOTES.

Birkenhead.—The estimates of the borough treasurer, which came before a special meeting of the T.C. last week, show that the electric tramways of the borough have saved ratepayers from the burden of a heavy increase in the rates to the extent of 4d. in the £. A month ago such a rather large increase seemed inevitable to the Finance Committee, but owing to the rapid development of the tramways, an increase of only 1d. will suffice. The Finance Committee were reckoning on having to find at least £2,000 towards the working of the municipal electric tramways system, but the single route between Woodside and New Ferry has proved so remunerative during the first two months, that, in view of the early opening of other routes, the committee have come to the conclusion that instead of the electric tramways costing the ratepayers £2,000 during the current year for working expenses, there will be a surplus from the earnings, after paying the working expenses, of at least £6,000. The committee have based their calculations on the working of electric tramways in other towns, and appear to be confident that the favourable result indicated will be realised. But for the electric tramways it would have been necessary to raise £13,000 in excess of the needs of the previous 12 months.

Cape Town.—The Camp's Bay terminus of the electric tramway which is to connect Sea Point and Camp's Bay and the Kloof is now being erected. The works are situated near the main road at the end of Camp's Bay furthest from Sea Point. The tramline has been laid over the whole distance.

Chatham.—The T.C. has approved plans for the erection of an electric energy station and works at Luton for the Chatham and District Light Railway Company.

Glasgow.—The two Allis engines, of 5,000 H.P. each, had a successful trial run on the 10th inst. The Stewart auxiliary engines, two in number, of 1,000 H.P. each, have also had a successful run. The exciting plant, consisting of six 250-H.P. 100-volt W. H. Allen & Co.'s combined sets, is now complete. Everything points to a very favourable inauguration on the 24th inst. The memorial tablet bears the names of Samuel Chisholm, Lord Provost, Walter Paton, convener tramways department; John Young, general manager; and Horace Field Parshall, consulting engineer.

Halifax.—Our local correspondent writes:—"In connection with the electric tramway extensions at Halifax, the Tramways Committee's American scheme of a 'lift,' after the pattern of one in operation at Cincinnati, by which to negotiate the hill at the southern boundary of the borough, is arousing much opposition. The estimated cost is £12,000. The municipality is strongly in its favour. A town's meeting will shortly voice its opinion on the project."

Kinver.—The electric railway has now been opened for traffic, but the Board of Trade have limited the speed for a time on the route. When, however, the embankment through the meadows has had more time to consolidate it is hoped that the speed will be increased. The line seemed inadequate to cope with the Easter traffic. Waggonettes were running from Stourbridge to Kinver in large numbers; and the astute proprietors asked a florin to bring home people who had made the outward journey on the electric railway for the modest threepenny bit.

Lincoln.—Mr. A. Brown, city surveyor of Nottingham, has been requested to advise and confer with the Electricity Committee of the Lincoln City Council on several matters in connection with the undertaking of the Lincoln Tramways Company, which now runs the cars by horse-power, and which the Corporation contemplate buying out with the view of substituting a line of electric trams on the overhead wire system.

Liverpool.—The claims which have been made in respect of personal injuries and damages by accidents on the Liverpool tramways, have reached so substantial an aggregate, that the Ocean Accident and Guarantee Corporation, with whom the Corporation of Liverpool insured themselves against such claims, have been called upon to pay the full amount of the liability under their policy. Consequent upon this, correspondence has passed between the company and the Town Clerk of Liverpool, with a view to a revision of the terms of the insurance. The subject came before the Finance and Traffic Sub-Committee at a recent meeting, and the following resolution was adopted, and subsequently confirmed by the General Committee:—"That on the representation of the company that they have paid, or are liable to pay, under their policy, claims exceeding the sum of £4,500, the total limit of their liability under the policy, the Town Clerk be instructed, as arranged with the representatives of the company, to deal with all claims at present outstanding and all further claims which may be made between the present date and June 7th, 1901, and that the controller and auditor of accounts be requested to audit the company's statement of claims paid, and report thereon to this committee." The attitude of the Ocean Accident Insurance Corporation in the matter will be better understood when it is stated that two months of the existing contract have yet to run.

Midland Railway and Electric Traction.—Our American contemporaries state that the Midland Railway Company has sent two engineers, Messrs. Seeley and Woolinscroft, to the United States to study American railway methods, including the adaptation of electricity to railways.

New York.—The Westinghouse Electric Company, of Pittsburg, has been awarded the contract for the complete motor and control equipment of all the elevated lines of the Brooklyn Rapid Transit Company, of New York. This system comprises over 30 miles of double track railway, which is one of the largest elevated rapid transit systems in America. The contract, we are informed, was awarded to the Westinghouse Company after a long series of trials and tests, each competitor furnishing a number of sample trains. These trials and tests extended over a period of nearly three years. We are told that the other competing firms were the General Electric and the Sprague Electric Companies, of America, each of which offered an electric system of multiple unit control in competition with the electro-pneumatic system proposed by the Westinghouse Company. The Westinghouse system, which has been adopted by the Brooklyn Rapid Transit Company, is the same as that which the British Westinghouse Electric and Manufacturing Company, Limited, has proposed for operating the trains of the Metropolitan and the Metropolitan District and other underground railways in this country.

New Zealand.—We understand that the Roslyn Tramway Company, of Dunedin, which was the first to introduce cable tramways in the Australasian Colonies about 20 years ago, has just introduced an electric tramway into New Zealand. The line commenced running for public service last October, and was formally opened on December 4th. The overhead trolley system has been adopted, and the whole of the work in connection with the track, cars, and power station equipment has been carried out by the British Westinghouse Company. It is interesting to note the effect of the conversion of the lines on the traffic returns. It was found that during the first five weeks of electric operation an increase of 96 per cent. over the last five weeks' traffic on the old system was shown. The Dunedin City Council have resolved to buy up the local tramway companies' undertakings, and equip them throughout with electric power transmitted from some waterfalls distant about 12 miles from the city. A preliminary sum of £250,000 is to be borrowed for this purpose.

Northampton.—At a meeting of the T.C. on 10th inst., the proposed acquisition by the Council of the Northampton street tramways—at present worked by horse-power—was considered in committee. When the Council resumed its public deliberations, Councillor Wooding, on behalf of the Tramways and Electric Light Committee of the Town Council, moved the following :—

> The Committee report that the negotiations with the Tramways Company for the purchase of the undertaking have not resulted in an agreement, and they will in due course propose, in pursuance of the resolution of August 20th, 1899, to take the necessary steps to acquire the tramways under the statutory power of purchase.

Alderman Randall, who seconded, said that the offer of the Committee was most generous. The resolution was carried unanimously.

Peterborough.—Some time ago the British Electric Traction Company made an application to the Peterborough Corporation with respect to the supply of motive power for the electric trams. In the course of an interview with the Council last Friday, Mr. E. A. Parris said that the company offered to pay 2d. per unit up to a certain point, and 1½d. per unit for the next part, the minimum guaranteed requirement being 120,000 units. The engineer was instructed to visit various towns at his discretion to make full inquiries and report.

Paisley.—At the forthcoming meeting in Glasgow, held under the new system of Private Bill Procedure Act, 1900, the Corporation intend opposing Mr. Murphy's provisional order, known as the Paisley District Tramways Bill. The Council have been unable to come to terms with Mr. Murphy. They are still going on with their own provisional Bill, however.

Russia.—It is reported that a project has been submitted to the Russian Government for the construction of an express electric railway between St. Petersburg and Moscow, a distance of 610 kilometres.

Salford.—The work of relaying the rails for the electric tram service is proceeding briskly. The Pendleton, Cross Lane, Trafford Road, and Broughton routes have been completed, and work has just commenced in Eccles New Road beyond Weaste, and in Bolton Road, Pendleton. The cars may be running in November.

Soothill Upper.—Not long ago Mr. Parris, of the British Electric Traction Company, attended a meeting of the General Works Committee, and asked if the Council were willing to purchase that portion of the Dewsbury, Batley, and Birstall Tramways which lies within the district of Soothill Upper, on condition that the Traction Company find the purchase money, and then for the Council to lease such line to the company for 35 years, at £1 per annum. The clerk was instructed to communicate with the town clerk of Dewsbury, and obtain a copy of the agreement between the Traction Company and the Corporation.

Sunderland.—There is every appearance that the Electrical Tramways Committee will have to deal with a trouble with their men, chiefly the conductors, for they have given notice to strike unless their wages are increased from 22s. 6d. to 25s. per week. The men state that an advance was promised them, but this is denied, and the Committee refuse to advance the wages as the conditions of service have been much improved.

Swindon.—As a result of the recent visit to Swindon of Colonel Yorke, Board of Trade inspector, who made an exhaustive inquiry into the projected scheme of electric trams, and inspected the various routes to be traversed by the said trams, the Board of Trade have granted a provisional order authorising the Corporation of Swindon to construct trams in the borough. Already a piece of land has been purchased as a site for a generating station, and Messrs. Siemens Bros. & Co. have been entrusted with the contract for the provision of engines and dynamos; tenders will be immediately requested for the erection of the necessary buildings, the plans, &c., for which have been prepared by Messrs. Lacey, Clirehugh & Sillar. In all about 10 miles of way, of which about 2½ will be double and the remainder single line, will be constructed under the scheme as it at present stands.

Taunton.—At the monthly meeting of the Taunton Town Council, held on April 9th, it was decided to make certain small alterations and works as asked for by the Tramway Company. The form of the contract to be entered into by the Newton Electrical Works for the laying down of the electrical plant for the supply of energy for the trams was signed. Negotiations between the Corporation, the Tramways Company and Messrs. Newton, have resulted in an arrangement, under which the Tramways Company will postpone the date under which the Corporation is liable to supply energy, namely, July 1st to August 1st next, on which latter date Messrs. Newton & Co. undertake by their contract that the Corporation shall be in a position to supply energy. Under the contract Messrs. Newton & Co. also guarantee the proper working of the plant for seven years.

Twickenham.—The U.D.C. have instructed their clerk to consent to the London United Tramways Bill if the company agree to accept the terms already submitted by the Council.

Wolverhampton.—The Corporation Tramways Committee have had under consideration since their return from Paris, an American patent for electric traction on the stud or conduit system. The method has been explained to the chairman of the Committee, Alderman C. T. Mander, by an expert in London. It is not, however, proposed that the Committee shall go to New York to inspect this system in operation.

TELEGRAPH AND TELEPHONE NOTES.

Aberdeen Telephones.—At a meeting of the Special Telephone Committee of the T.C. on 11th inst., Mr. Bennett, who has been engineer for the Glasgow Corporation in establishing municipal telephones, was present, and explained what had been done throughout the kingdom in the municipalisation of the system. It was resolved that Mr. Bennett should draw up a report as to the approximate cost, &c., of a municipal system of telephones, covering the present area over which the National Telephone Company has wires in the city.

French Cables.—In reference to the doings of the cable ship *Diolibah* at Amoy, Reuter reports that advices from that place say that the French cable is connected at Chapel Island, and is thence taken to Saigon. The Amoy end has not been hauled ashore, but the cable is attached in readiness.

London Telephones.—It is stated in a morning paper that an order for telephones and switchboards for London was recently placed with the Western Electric Company by the postal authorities.

New Cable.—A *Times* dispatch from Sierra Leone says that on 14th inst. the cableship *Anglia* began the laying of the direct cable connecting Ascension with the mainland.

Queensland Telephones.—The many friends in this country of the electrical engineer in the Queensland post and telegraph department (Mr. J. Hesketh) will be interested to learn that he has just returned to Brisbane from a visit to the Northern portion of the colony, made principally in connection with the opening of the new telephone trunk line between Townsville and Charters Towers. The *Brisbane Courier* says that the telephone service between those towns up to the 13th inst. had been worked on the two existing telegraph lines, which were used for telephoning at the same time as for telegraphing. It is worthy of note that this was the first telephone service by a trunk line in the colony, and on its results the fixing of the other trunk lines was justified.

Railway Telegraphs.—Mr. Alexander Spark, of Aberdeen, has been ordered to supply the Great North of Scotland Railway Company with telegraph apparatus for the complete equipment of the stations along their lines, to recent Board of Trade requirements.

Telegraphic Interruptions and Repairs :—

Cables.	Interrupted.	Repaired.
Taku-Chefao	.. March 29, 1901 ..	..
Conakry-Sierra Leone	.. April 2, 1901 ..	April 16.
Singaradja-Macassar	.. April 14 ..	..
Fao-Bushire	.. March 6, 1901 ..	April 11.
Perim-Obock	.. March 22, 1901 ..	April 15.
Latakia-Cyprus	.. June 20, 1899 ..	..
Para-Maranham	.. March 1, 1900 ..	..
Landlines :—		
Siberian landlines—		
Blagowestchensk-Chabarowsk ..	.. April 3, 1901 ..	April 10.
Chinese landlines—		
Pekin-Kalgan	.. June 14, 1900 ..	..
Tientsin, *via* Shanghai	.. June 16, 1900 ..	..
Kalgan-Maimatchin	.. June 30, 1900 ..	..

Telegraphy and the South African War.—In Lord Roberts's dispatches, which have been published this week, the following appreciative remarks are made regarding the telegraph service :—

Army Telegraphs.—The duties performed by the army telegraphs under Lieut.-Colonel R. Hippisley, R.E., throughout the war have my entire approbation. No portion of the army has had more work or greater responsibility than this branch. With a *personnel* of 25 officers and 1,221 operators, linesmen, &c. (of whom 4 officers and 153 N.C.O.'s and men have died or been invalided), nearly 2½ millions of messages have been dealt with during the past 13 months, some of them containing as many as 4,000 words. The telegraph systems taken over, repaired, and maintained exceed 3,300 miles in length, with over 9,000 miles of wire. In addition, 959 miles of air line have been erected and 1,145 miles of cable laid. Great credit is also due for the quick way repairs to the lines, so frequently interrupted by the Boers, have been carried out. This is a most dangerous service, as there is always a chance that the enemy may be lying in wait near the break, but there has been throughout the most unhesitating promptitude in its performance. The young officers in charge of cable carts have also often had perilous work to perform when winding back their wire, alone or with a very small escort.

Submarine Telegraphs.—The working of the submarine telegraphs was most satisfactory, and the liberality of the companies in giving special rates for soldiers was much appreciated by the army.

Wireless Telegraphy.—The directors of the Cunard Steamship Company have for some time past had the Marconi system of wireless telegraphy under consideration, with a view to adopting it for communicating between their steamers and points on shore. It is now stated in Liverpool that the directors have decided to provide Marconi instruments on their Atlantic steamers, but further improvements will be necessary before the full advantage of the system can be availed of.

The New York correspondent of the *Daily Telegraph* says that the Board appointed to consider the adoption of wireless telegraphy for the navy has completed its work. It will probably recommend the employment of the system by the North Atlantic Squadron in the August manœuvres.

CONTRACTS OPEN AND CLOSED.

OPEN.

Aberdeen.—April 27th. The E.L. Committee wants tenders for six water-tube boilers and accessories. See "Official Notices" April 12th.

Alloa.—April 25th. The E.L. Committee wants tenders for insulated cables, joint boxes, &c.; arc lamps and pillars; sub-station equipment and sundry connections. See "Official Notices" April 12th.

Ashton-under-Lyne.—April 29th. The Electricity Committee wants tenders for two continuous current generators, each of 250 to 300 H.P., with double acting enclosed engines. See "Official Notices" to-day.

Aylesbury.—April 22nd. The U.D.C. wants tenders for establishing and maintaining electricity works. See "Official Notices" March 22nd.

Barrow-in-Furness.—April 24th. The Corporation wants tenders for concentric cables, boxes, cast-iron pipes, conduits and pipes, balancing transformer and switchboards. See "Official Notices" April 5th.

Battersea.—April 30th. The Council wants tenders for electric pumps and pipe work, river work, pipe and pits, &c. See "Official Notices" March 29th.

Battersea.—The Borough Council invites firms to submit free wiring proposals. See "Official Notices" April 12th.

Bradford.—The Bradford Corporation are about to advertise for material for the overhead equipment of the Manchester Road Tramway. They have decided to use Cooper's patent joint rails throughout this route.

Cardiff.—April 30th. The Corporation wants tenders for poles, bases, brackets, feeder and section pillars, trolley and other wire, insulators and line suspensions, for electric tramways. See "Official Notices" April 12th.

Copenhagen. — May 4th. The Corporation wants tenders for the supply of a network for a new central station. See "Official Notices" April 12th.

Dublin.—April 22nd. The Lighting Committee wants tenders for condensing plant, pipework, feed pump, superheaters, mechanical coaling apparatus, crane, and workshop equipment. See "Official Notices" March 22nd.

Dundee.—May 1st. The T.C. wants tenders for copper bonds. See "Official Notices" to-day.

Edinburgh.—April 20th. Tenders are wanted by the Corporation for arc lamp carbons and cast-iron pipes. See "Official Notices" March 29th.

Germany.—May 1st. The Prussian State Railway Authorities at Munster are inviting tenders until May 1st for the supply of a steam engine and dynamo. Particulars can be obtained from, and tenders are to be sent to, Die General Direction der Königl Eisenbahnen, Munster.

Great Eastern Railway.—May 14th. The directors want tenders for the supply of stores and materials. There are 23 different sections, including one for telegraph materials. See "Official Notices" to-day.

London.—April 24th. The Metropolitan Asylums Board invites tenders for gas-producing plant and gas engines, dynamos, accumulators, and switchboard; Galloway boilers, economiser, feed pumps, &c., for Tooting Bec Asylum. See "Official Notices" March 22nd.

Madrid.—April 21st. The Secretary of State for Foreign Affairs has received a despatch from his Majesty's Ambassador in Madrid, stating that tenders are invited by the Spanish Government, not later than April 21st, for the establishment and working of a telephone system in Palencia. Particulars may be examined at the Commercial Department of the Foreign Office, between 11 a.m and 5 p.m.

Manchester.—May 7th. The Electricity Committee wants tenders for water-tube boilers; plant of 15,000 I.H.P. in generating and sub-stations, comprising steam engines, &c., three-phase generators and motor transformers. See "Official Notices" April 12th.

Middlesbrough.—April 30th. The E.L. Committee wants tenders for a Lancashire boiler, 300-KW. steam dynamo, condensing plant, and piping. See "Official Notices" March 29th.

We would draw tenderers' special attention to the latest date for sending in estimates. It is April 30th and not 13th, as appeared in our "Official Notices."

Middleton.—April 27th. The Corporation invites tenders for the erection of a refuse destructor to work in conjunction with the electricity works. Mr. F. Entwistle, Town Clerk, Town Hall.

Motherwell.—April 29th. The T.C. wants tenders for steam dynamo and switches and piping. See "Official Notices" March 29th.

Norwich.—May 7th. The Norwich Mutual Telephone Company, Limited, is about to establish a telephone exchange, and invites tenders for cables, wires, pipes, ironwork, poles, insulators, batteries, telephones and other instruments, switchboards, &c., required in connection therewith. See "Official Notices" April 12th.

Partick.—The Council wants tenders for main switchboards and instruments, battery and accessories. See "Official Notices" April 12th.

Piatra Neamtz, Roumania.—April 23rd (new style). The mayor will on this date consider offers for the concession of supplying the town with electric light for a term of 30 years.

Portsmouth.—April 30th. The Corporation wants tenders for various works in connection with the establishment of the municipal telephone system :—conduits and cables, copper and other wire, ironwork, insulators, switchboards, batteries, telephone instruments, poles, arms, &c. See "Official Notices" April 12th.

Poplar.—May 1st. The Guardians want tenders for steam, exhaust, and other piping, valves, &c. See "Official Notices" April 5th.

Southampton.—April 29th. The Corporation wants tenders for the supply of stores, fittings, &c., required for the electric tramway department during 12 months. Specifications, &c., from the manager at the Tramway Office, Prospect Place, Southampton.

Southwark.—April 19th. The Council wants tenders for incandescent lamp brackets, switches and fittings, for gas standards. See "Official Notices" April 5th.

Spain.—April 28th. The Secretary of State for Foreign Affairs has received dispatches from Madrid stating that tenders are invited by the Municipality of Lopera (Jaen) for the concession of the exclusive right of lighting the town by electricity; by the Spanish post office, to be received not later than May 10th, for a concession for the establishment and working of a telephone system at Denia; and by the Spanish Government, to be received not later than June 3rd, for a concession for working a system of electric tramways at Barcelona, the concession already granted having been annulled.

Motherwell.—May 18th. The E.L. Committee wants tenders for cast-iron lamp columns, arc lamps, switches, fittings, &c.

Sunderland.—April 26th. The Corporation wants tenders for steam and other piping, and panels for traction switchboard. See "Official Notices" April 12th.

Tonbridge.—May 30th. The U.D.C. wants tenders for Lancashire boilers, two 50-KW. steam dynamos, condensing plant, crane, switchboard, battery, mains, arc and incandescent lighting, house meters, &c. See "Official Notices" April 12th.

CLOSED.

Ayr.—Mr. Frederick Coutts, Dundee, has now taken up his work as tramways manager. The Corporation has accepted the following additional tenders:—Switchboards, Messrs. Cowans, Manchester, £1,600; boilers, the Stirling Boiler Company, Stirling, £2,471; accumulators, the Electric Power Storage Company, Limited, London, £1,527; balancers and boosters, the General Electric Company, Limited, Manchester, £525; condensers, Messrs. Alley & Maclellan, Glasgow, £1,220.

Bolton.—The Electricity Committee at their last meeting had before them the report of their engineer (Mr. Day) upon the tenders for supply of generators, and the tender of the English Electric Manufacturing Company, Limited, was accepted for the supply of two 900-KW. generators. The tender of Messrs. Mather and Platt was accepted for the coupling together of two balancers at the electricity works. The recent Eastertide has witnessed some heavy traffic on the cars, but the management have been much handicapped by the non-delivery as yet of the full complement of vehicles on order. The department established what was practically a record on Good Friday, when over 106,000 passengers were carried.

Bournemouth.—The following is a list of the tenders submitted in connection with the Corporation electric tramway scheme:—

CONTRACT No. 1.—Thirty-eight electric cars and other works in connection therewith.

Bramigk & Co.	£35,025	0	0
Siemens Bros. & Co.	30,970	0	0
Robert Blackwell & Co.	30,374	0	0
Hungarian Railway Carriage & Machine Company	30,030	0	0
Hurst, Nelson & Co.	29,472	4	0
British Thomson-Houston Company	29,764	2	0
Brush Electrical Engineering Company, Limited	28,381	0	0
British Westinghouse Electrical & Manufacturing Company, Limited (accepted)	28,020	0	0

One informal tender was also received.

CONTRACT No. 2.—Four steam dynamos, and other works in connection therewith:—

Brush Electrical Engineering Company, Limited	£18,930	0	0
British Westinghouse Electric & Manufacturing Company, Limited	17,857	0	0
British Schuckert Company, Limited	17,453	0	0
Brush Electrical Engineering Company, Limited	17,250	0	0
British Westinghouse Electric & Manufacturing Company, Limited	16,284	0	0
British Schuckert Company, Limited	16,145	0	0
Anchor Electric Company	15,900	0	0
Johnson-Lundell Electric Traction Company	16,135	0	0
Lancashire Dynamo & Motor Company, Limited	15,406	0	0
British Schuckert Company, Limited	15,485	0	0
Anchor Electric Company	15,200	0	0
Anchor Electric Company	15,100	0	0
Lancashire Dynamo & Motor Company, Limited	14,844	0	0
Siemens Bros. & Co.	14,800	0	0
British Thomson-Houston Company	14,733	0	0
Johnson-Lundell Electric Traction Company	14,283	0	0
British Thomson-Houston Company	13,998	0	0
Bow, McLachlan & Co.	14,000	0	0
C. A. Parsons & Co.	13,418	0	0
British Westinghouse Electric & Manufacturing Company, Limited	11,982	0	0
British Thomson-Houston Company	12,321	0	0
C. A. Parsons & Co.	12,531	0	0
Siemens Bros. & Co.	12,199	0	0
Lancashire Dynamo & Motor Company, Limited	11,982	0	0
C. A. Parsons & Co.	12,220	0	0

Bradford.—The tender of the Patent Nut and Bolt Company for tie bars and fish-bolts, at £12 10s. per ton, for the construction of the Manchester Road tramway, has been accepted by the Corporation. The Corporation has decided to try two of Spencer & Gledhill's patent fare boxes. The Corporation has accepted the tender of Messrs. Thornton & Creppin, of Bradford, for 75 complete sets of castings, forgings, and turned work required for slipper brakes for electric tramcars at £12 4s. per set.

The Corporation has accepted the tender of Messrs. Babcock and Wilcox, Limited, for steam piping and valves for Valley Road electricity works at a cost of £186, and the tender of Messrs. W. B. Haigh & Co., Limited, of Oldham, for five grease separators for the same works at a total of £870.

Durban, Natal.—The tender of Mr. W. F. Johnstone for the erection of the electric tramways power station, in Alice Street, has been accepted. The cost is £9,657, and the work is to be completed in nine months.

Hastings.—The T.C. has given contracts for electric light extension plant as follows: Babcock & Wilcox for two boilers with economiser, piping, &c., for £3,100; Wheeler Condenser Co. for piping, feed pump, hot well, &c., for the new Parsons turbo-alternator at £546; British Westinghouse Co., 100 electricity meters.

London, S.E.—The tender of Mr. Joel to erect accumulators at the Grove Park Workhouse, at a cost of £500, has been accepted by the authorities.

Openshaw.—The Electrical Company, Limited, of Charing Cross Road, W.C., have secured through their Manchester Branch, the order for an 800 KW. slow speed direct current generator, from Sir W. G. Armstrong, Whitworth & Co., Limited, Openshaw. We are informed that there were a great many competitors, both Continental and American.

Sunderland.—The T.C. has given a contract to Messrs. Callender's Cable Construction Company, Limited, for the supply for the next three years of bitumen-covered cables. Ald. Bruce said the proposed contract was based on an existing contract which had been obtained in open competition, besides which the contract was accompanied by a sliding schedule to meet the fluctuations in the price of copper, and by which the prices would be periodically fixed. He added that the chief reason for entering into the contract was to avoid the probability of the introduction of other kinds of cable. Some opposition was offered to the suggestion on the grounds that the Council would thus be debarred from taking advantage of any improvements that might be achieved in cable-making during the period, but eventually the contract was passed.

Whitehaven.—The E.L. Committee has given a contract for electric light mains to Callender's Cable Company at £2,782.

Wolverhampton.—The T.C., at the monthly meeting on Monday, accepted the following tender:—Callender's Cable Construction Company, Limited, tender amounting to £6,710 1s. 3d., for supplying, laying, and erecting complete the necessary conduits, feeders, and feeder switch pillars for the electrical equipment of the line of tramway running from the borough boundary at Bilston Road to the Upper Green, Tettenhall, including a short length on the Cleveland Road up to the car shed. The Tramways Committee were also authorised to accept such tender as they shall deem advisable, at a sum not exceeding £6,500, for the overhead electrical equipment of the length.

FORTHCOMING EVENTS.

Friday, April 19th.—At 9 p.m. Royal Institution. Discourse by Prof. J. J. Thomson, F.R.S., on "The Existence of Bodies smaller than Atoms."

Saturday, April 20th.—At 7.30 p.m. Annual Conversazione at the South-Western Polytechnic, Manresa Road, Chelsea, S.W. Distribution of prizes, &c., by Sir W. H. Preece. Formal opening of the new buildings to follow. The programme of arrangements is a very attractive one, and includes lecturettes on "Production of High Temperatures," by Prof. Coleman; "Wireless Telegraphy," by Mr. W. H. Eccles; "Great Achievements of Engineering," by Prof. Pullen; "Modern X-ray Photography," by Mr. F. J. Addyman; and "Growing Crystals," by Prof. Schwartz.

Monday, April 22nd.—At 8 p.m. Society of Arts. Cantor Lectures. I., "Alloys," by Sir William C. Roberts-Austen, F.R.S.

Tuesday, April 23rd.—At 7.30 p.m. Annual meeting of the Manchester Section of the Institution of Electrical Engineers.

Wednesday, April 24th.—At 8 p.m. Society of Arts, Ordinary Meeting. Paper on the "Patent Law Reform" by Alexander Siemens.

At 7.30 p.m. Institution of Electrical Engineers (Students' Section). Meeting. Paper to be read on "Distribution of Energy in Coal Mines" by F. E. Pring.

Thursday, April 25th.—At 8 p.m. Institution of Civil Engineers. Special Meeting. Ninth "James Forrest" Lecture, by Prof. F. Clowes, on "Chemistry in its Relations to Engineering."

At 8 p.m. Institution of Junior Engineers. At the Westminster Palace Hotel. Sixth and concluding Lecture on "Works' Management," by Mr. A. H. Barker.

Friday, April 26th.—At 8 p.m. Society of Arts. Howard Lecture, by A. C. Eborall, on "Polyphase Electric Working" (Lecture I.). The general treatment of polyphase problems: two-phase and three-phase systems—The general requirements of polyphase plant—Polyphase generators: standard types and leading features of design—Efficiency and pressure regulation—Short circuit current and pre-determination of the pressure drop on non-inductive and inductive loads.

Saturday, April 27th.—Institution of Electrical Engineers. (Students' Section.) Visit to the works of Messrs. Easton, Anderson & Goolden.

ELECTRIC CONDUIT TRAMWAYS.

A propos of the paper recently read before the Institution of Mechanical Engineers by Mr. A. N. Connett, of which we published an abstract, we give below some additional views of the conduit tramways in Paris and Nice. For the originals of these we are indebted to the courtesy of Mr. Connett, who, as chief engineer to the Campagnie Française Thomson-Houston, was responsible for the design and execution of the whole of the work in question.

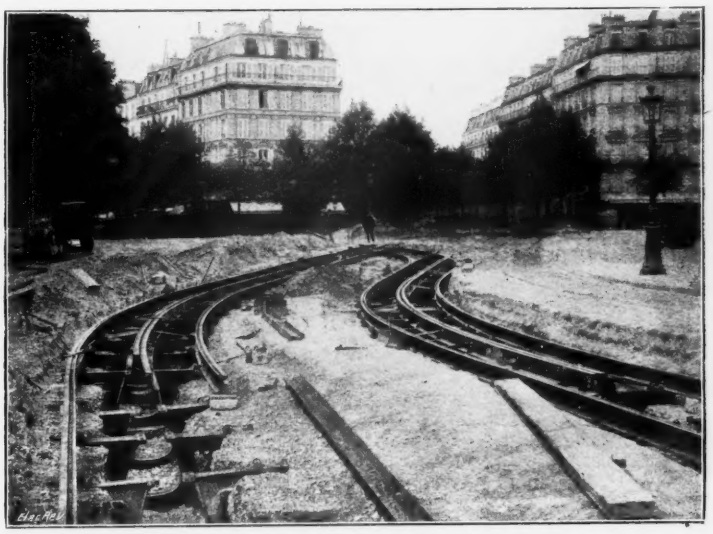


Fig. 1.—Paris, Place Dumesnil.

Fig. 1 is a view of conduit tramway curves, equipped with the centre slot, in course of construction at the Place Dumesnil, in Paris. The figure shows the ironwork placed in position before the concrete tube has been made. This piece of construction was the first conduit laid in Paris on what is called the Bastille—Charenton line.

Fig. 2 shows a slot cross-over on the Bastille—Montparnasse line. This construction is located directly in front of the Gare Montparnasse, and the cross-over in question serves as a terminus for this line. The conduit shown is the centre slot, though the construction of the line in question is the side slot; wherever slot switches were used, the slot was deflected to the central position. The figure shows the ironwork in position, and practically ready for concreting.

Fig. 3 shows a curve and slot turn-out on the Etoile—Montparnasse line. The figure shows distinctly the yokes and the tie-rods holding the slot rails in position.

Fig. 4 is a view of a special construction on the St. Ouen—Champ-de-Mars line. The side slot conduit is here shown clearly. The method of placing the tie-rods for such a construction is also clear in this figure. Between the two tracks may be seen the girder of the railway bridge, which the conduit tramway crosses here. The conduits themselves are made up of longitudinal girders, which have to be self-supporting between the points of support on the cross-girders of the steel bridge. The construction is a special one, and shows how to construct conduits where such an obstacle is met with.

Fig. 3.—Curve and Slot Turn-out, Etoile-Montparnasse Line, Paris.

Figs. 5 and 6 show a centre slot conduit in the city of Nice. The gauge of the tracks here is 1 metre, otherwise the construction does not differ from the centre slot construction shown in figs. 1, 2 and 3.

F

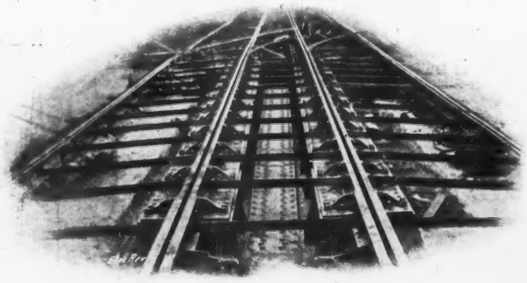
MANCHESTER ELECTRIC POWER STATIONS.

(*Concluded from page* 634.)

Owing to their large size the cables could not be made in greater lengths than 110 yards, and hence a considerable number of joints were necessitated. The method of jointing is described below :—

The cables are all laid on Callender's solid system in cast-iron troughs. The latter are in 9 ft. lengths, and contain either two or three cables each. Ordinary wooden bridges are used, but in addition to these one bridge in every length of troughing is of malleable iron, secured to the bottom of the trough by set screws, and a malleable iron clamp is placed over the cable so as to secure efficient contact between the armouring and the length of troughing. By this means the cast-iron trough is rendered electrically continuous throughout the length of the cable. The troughs are covered by pitch pine boards 1¼ in. thick, treated with Stockholm tar all over.

Electric Conduit Tramways.—Fig. 2: Slot Cross-over, Gare Montparnasse, Paris.

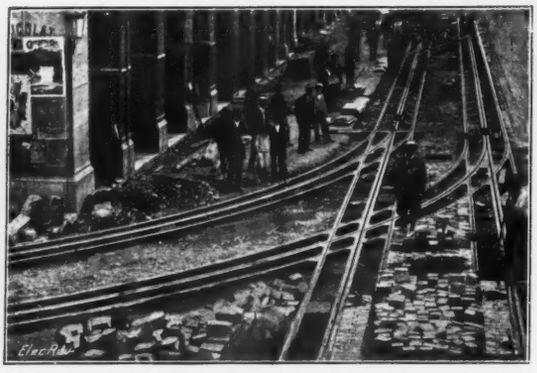


Electric Conduit Tramways.—Fig. 4: Special Side slot Construction over Steel Railway Bridge, Paris.

The joint boxes were specially designed by Mr. Wordingham for the work, and are shown in figs. 1 and 2. The boxes are of such a shape that the three conductors can be bent outwards from the centre of the cable, and have not to be brought into one plane. The brass connecting pieces are carried on porcelain insulators, giving very high insulation in air. These insulators are gripped at the bottom of the box by two wedge-shaped lugs cast in the bottom, and a third of similar shape fixed by a set screw, while the brass connecting pieces which they support are rigidly held by means of a kind of bayonet joint. The whole of the box is filled up with Callender's box compound, so that although the insulators are amply sufficient to insulate the conductors in dry air, this is not relied upon, but is supplemented by means of the compound, which has a very high dielectric strength.

Another feature of these boxes, suggested by Mr. F. E. Procter, mains engineer, who was responsible to Mr. Wordingham for the laying of the mains, consists in clamping together the armouring and the lead by means of clamps on the box itself, thus very neatly and simply ensuring the efficient connection between these, and avoiding any want of continuity in the earthed shield round the conductors.

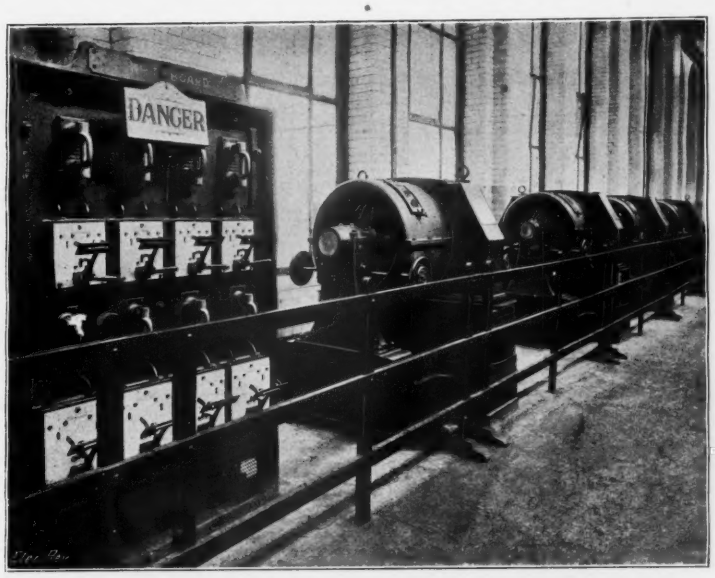
Owing to the high pressure it is unavoidable that the boxes should be somewhat bulky, and the method of leading the cables to them may be of interest. This is shown in fig. 3, which shows joints on cables in a trough containing two feeders. It will be observed that a **Y**-shaped casing is fixed to the end of the trough, and the two cables are taken into separate pieces of troughing, thence through the joint-box, and then again through a **Y**-shaped casing. The arrangement is very convenient; indeed, the whole of the jointing is carried out without any complication. Fig. 4 shows a similar arrangement for a group of three cables. It will be noticed that the principle employed by Messrs. Callender & Co. in their joint boxes has been utilised, namely, a sliding shutter to close the ends, thus enabling the sweating of the cables to be done outside the box.



Electric Conduit Tramways.—Fig. 5 Centre-slot Conduit Nice.

Electric Conduit Tramways.—Fig. 6 Centre-slot Conduit, Nice.

A large proportion of the cables required for the permanent scheme has now been laid, and three have been utilised for the temporary supply above described. As already stated, the mains brought into use comprise one from Dickinson Street to Moss Side station, another from Dickinson Street to Bennett Street sub-station, and a third from Moss Side to Bennett Street. These mains were all tested after laying with a pressure of 13,000 volts between each conductor and earth, the other two conductors of the cable and the armouring being connected to earth during the test; each conductor was tested in this manner in turn. The capacity of the conductors was similarly tested, and tests were made of the conductance of the cables. The results of the tests are all set forth in the accompanying table, the joint boxes being included in the test in all cases. The equality of capacity between the conductors of the cable is most noteworthy, this being of great importance in working with rotary converters. The requirements of the specification were very severe, but the result actually obtained was better even than that specified.



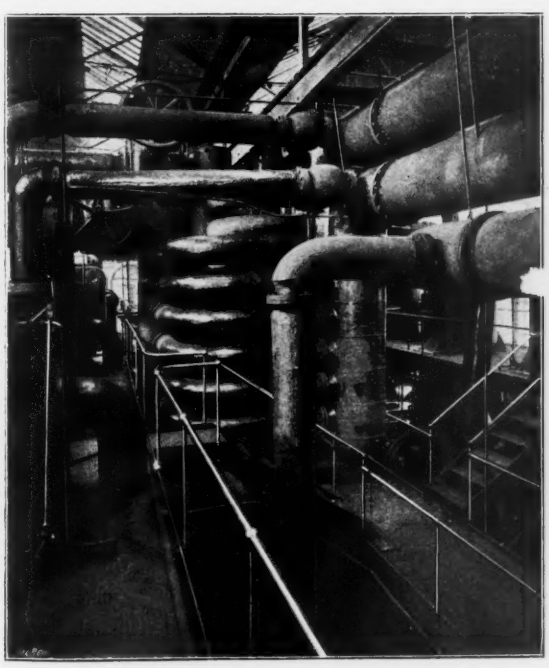
High Pressure Direct Current Transformers and Switchboard.

The resistance per mile of each conductor of 0·15 sq. in. cross-section was not to exceed 0·297 ohm at 60° F., nor to differ from the average by more than 1¼ per cent., and the capacity of each conductor, when the other two and the armouring were earthed, was not to differ from the average by more than 5 per cent. The dielectric was to withstand an alternating pressure of 20,000 volts between each conductor and any other and the lead for half an hour; further, half the cable on a drum was to be wound on another drum, and the bight between them bent six times in alternate directions round a drum 3½ ft. in diameter, after which the part which had been bent, when tested to breaking-down point, was not to be pierced under 30,000 volts. The contractors were also required to guarantee the cables for a period of five years.

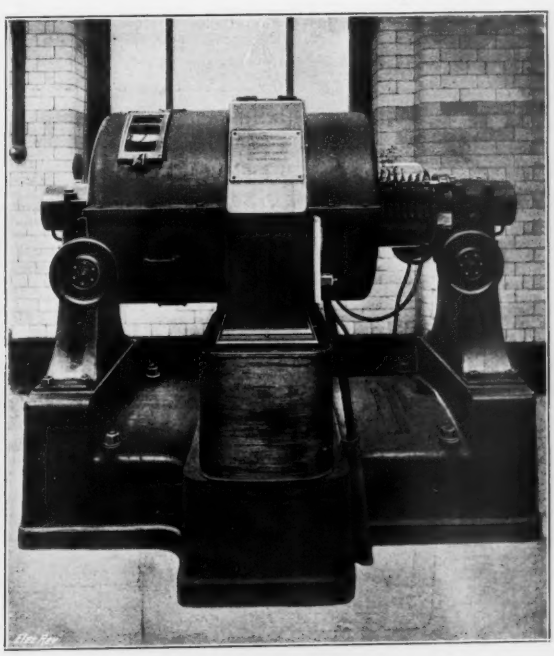
It is most satisfactory to know that the cables withstood a pressure test of 13,000 volts without the slightest hitch or mishap of any kind the first time the test was applied, a fact which speaks well both for the makers of the cables, and for the staff engaged in laying them.

Tests of High Pressure Three-phase Feeder Mains Laid on the Solid System.

	Copper resistance per mile.	Insulation resistance per mile.	Capacity per mile.
(1) Dickinson Street to Bennett Street.	A 0·291 ohm.	1,100 megohms.	0·240 mfd.
	B 0·291 „	336 „	0·243 „
	C 0·291 „	205 „	0·245 „
(2) Dickinson Street to Moss Side.	A 0·289 „	1,500 „	0·241 „
	B 0·294 „	1,200 „	0·239 „
	C 0·289 „	1,850 „	0·241 „
(3) Bennett Street to Moss Side.	A 0·293 „	265 „	0·243 „
	B 0·287 „	434 „	0·241 „
	C 0·288 „	536 „	0·243 „



Compound Expansion Joints.



60 kw. D.C. Transformer, 420 : 3,000 Volts.

No less than 27 miles of cable of this description were tendered for, as well as 7 miles of half the cross-section.

Before deciding on the adoption of three-phase transmis-

sion, Mr. Wordingham carried out an experimental installation of direct current machinery at a higher pressure than had up to then been employed, in order to test the possibilities of the D.C. system to the utmost. For this purpose four 60-KW. motor-generators were built, transforming up from 420 volts to 3,000 volts, and similar machines were installed in two sub-stations at points respectively three and four miles distant from Dickinson Street station, transforming down to about 416 volts. The step-up transformers in the generating station form the subject of two of our views, from which it will be seen that the high pressure commutators are of very large diameter, and are thoroughly cased in with cast-iron shields, so as to render accidental personal contacts practically impossible. The brushes are visible through glass windows, and are adjusted by means of tangent screws with insulating hand wheels. The high

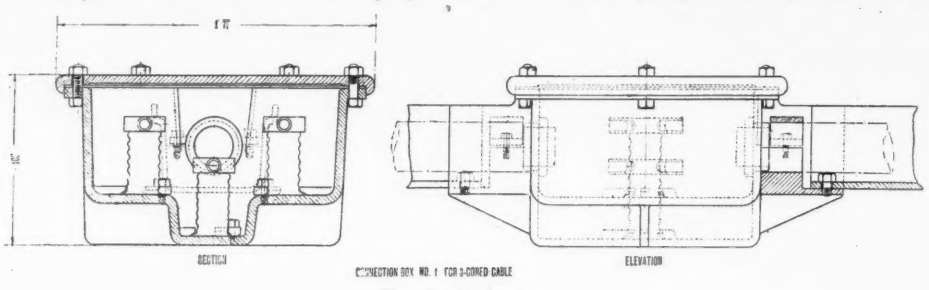
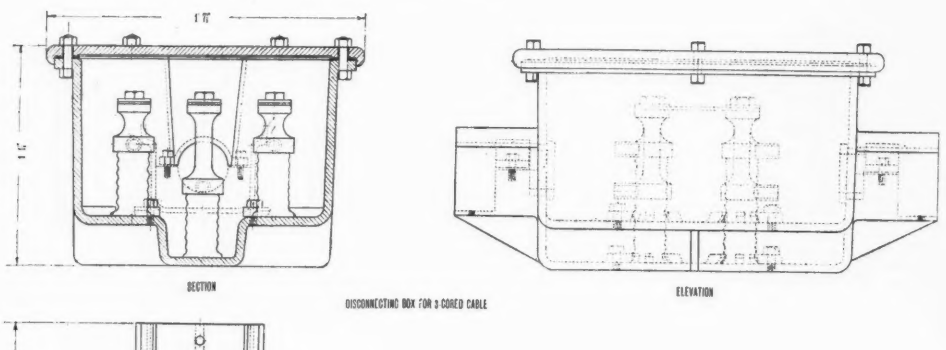


Fig. 1.—Scale $\frac{1}{10}$.



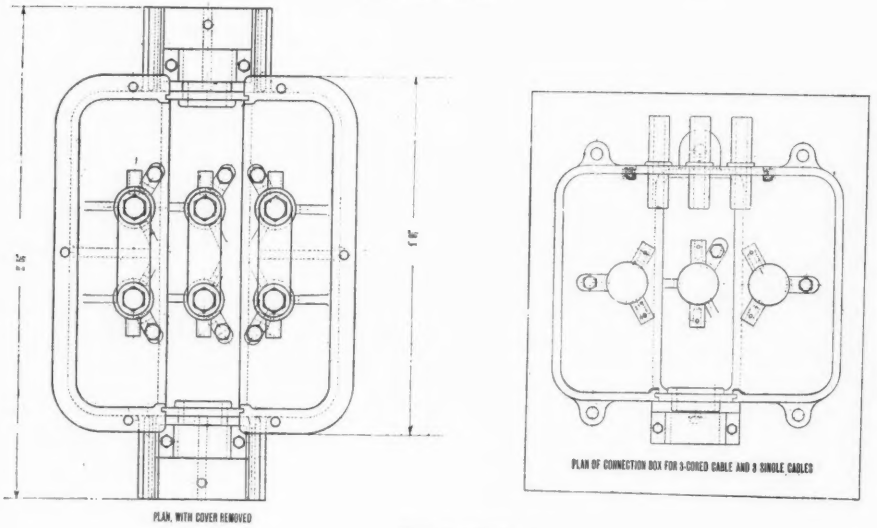
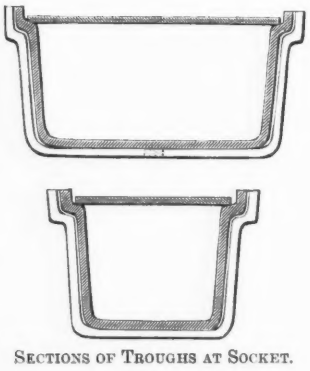
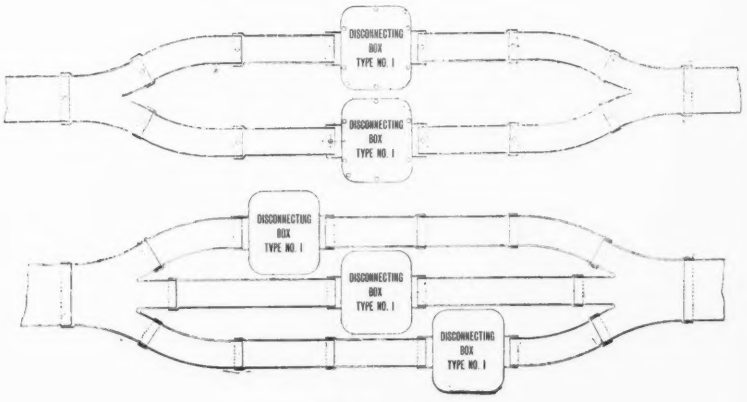


Fig. 2.—Scale $\frac{1}{10}$.

Fig. 3.



Sections of Troughs at Socket.
Scale $\frac{1}{10}$.


DISCONNECTING BOX TYPE NO. 1
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DISCONNECTING BOX TYPE NO. 1
DISCONNECTING BOX TYPE NO. 1

Fig. 4.—Scale $\frac{1}{10}$

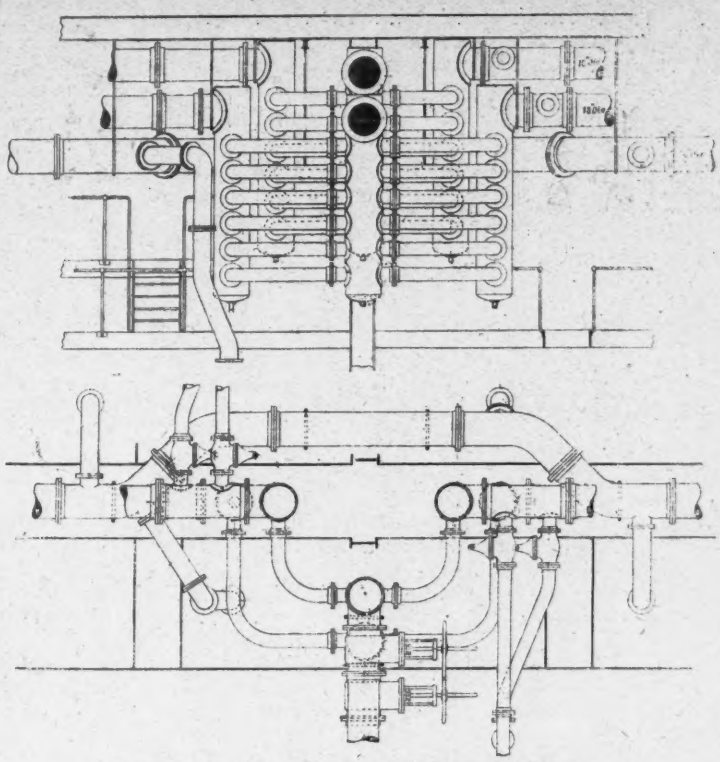
pressure current, after passing through the switchboard seen in one of the illustrations, is conveyed to the sub-stations through concentric cables drawn into pipes, with earthed outers. The step-down machines are provided with auxiliary field magnets for regulating the pressure, and feed direct into the outers of the three-wire network. Balancing is effected by the usual 1 to 1 motor-generators.

The machines ran sparklessly and well at the high pressure of 3,000 volts, and passed the tests with complete success; the results of efficiency tests on two sets were as follows:—

	First set. Per cent.	Second set. Per cent.
Full load	79·2	78·9
Three-quarter load ...	76·5	76·7
Half load	70·9	71·2
Mean	75·5	75·6

There was some delay in the delivery of the machines, and before they were installed Mr. Wordingham had satisfied himself as to the superiority of three-phase transmission. It was ultimately decided, therefore, to alter the connections of the high-pressure windings so as to give 1,500 instead of 3,000 volts, and the machines are now running at this pressure. They are entirely satisfactory, and have given no trouble whatever; they were supplied by the Electric Construction Company, Limited.

An interesting feature of the Dickinson Street station is the arrangement of the steam piping. This is in duplicate throughout, and owing to the shape and relative position of the boiler house and engine room considerable straight lengths of very heavy main piping were necessitated. One of the illustrations in our last issue showed part of the new boiler house; there are in all 18 Lancashire boilers and eight Babcock & Wilcox boilers, which, as well as the engine cylinders, steam pipes, &c., are covered with Messrs. Leroy & Co.'s non-conducting composition. The illustration referred to shows the very long **U**-bends inserted between the boilers and the main ranges in the boiler house, to take up the expansion. At this point the problem was comparatively simple; but in the engine room the mains from the boilers had to be teed on the main ranges running from end to end of the room, and expansion in three directions had to be provided for. Moreover, the main ranges were packed close together between vertical stanchions. The arrangement presented very great difficulties, but these were eventually overcome by the unique expansion joint devised by Mr. Wordingham, of which we give a photographic view, and a plan and elevation (fig. 5). These are self-explanatory. The joint works well, and has fully answered the requirements.



The drain pipes and traps have been omitted for greater clearness.

Fig. 5.—Compound Expansion Joints.

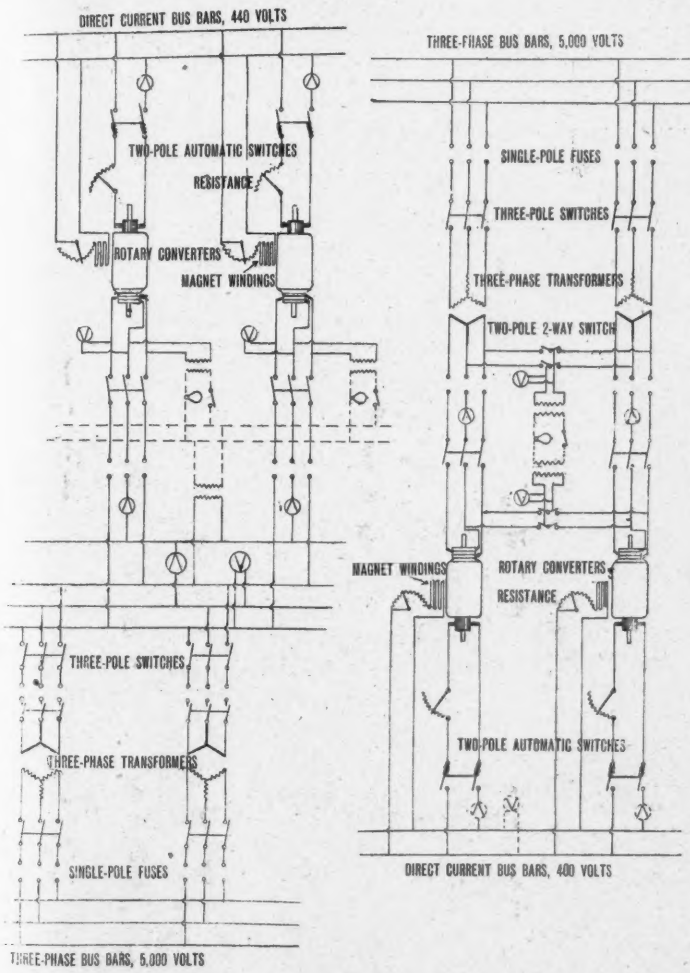


Fig. 6.—Diagram of Connections of Part of the Three-Phase Transmission Plant.

A short account of the Bloom Street generating station may be of interest. The difficulties of the site are considerable, and have been greatly increased by the necessity for getting plant of the maximum possible capacity into the space. The area of the site is 1,950 square yards, and on this is accommodated the whole of the plant, including boilers, economisers, chimney for natural draught, engines, dynamos, surface condensing plant, switchboards, &c., for developing 14,000 I.H.P.

Briefly, the arrangement is as follows:—The site is roughly oblong, but wider at one end than the other, no one corner being square. The engine room is parallel with one

long side, the boiler house is parallel with the other, the two touching at one end. At the base of the triangle formed by their sides is placed the chimney. The engine room will contain four generating sets, each of which is to consist of a compound condensing engine, with high-pressure cylinder 38½ in. diameter, low pressure 76 in., length of stroke 4 ft. 6 in., directly coupled to a direct-current dynamo running at 75 revolutions per minute. The machine is compound wound, giving 4,400 amperes at 410 to 440 volts when running as a shunt wound machine, and a proportionately reduced current at 500 volts when running as a compound machine. The plant is thus interchangeable for lighting or traction. It will give an output of 33 per cent. in excess of this for one hour, and 50 per cent. momentarily. The boiler house will contain 11 Babcock boilers, each having a heating surface of 5,140 square ft.; the whole is guaranteed to produce 200,000 lbs. of steam per hour at a pressure of 160 lbs. per square inch. All the boilers are fitted with superheaters. Above the boilers will be fixed the economisers, each boiler having its own economiser, and a reserve flue being provided for each pair of boilers. The main flues discharge into the chimney at a level of 30 ft. from the ground.

The chimney is octagonal, 230 ft. high, and 12 ft. across the octagon inside.

The steam pipes are completely duplicated, and are also arranged so that they can be cut up into sections, and certain boilers allocated to particular engines if desired.

The feed water arrangements are somewhat novel, inasmuch as a separate pump is provided for each boiler, the object being to secure that each economiser shall do its full amount of work—a difficult matter when several economisers are fed in parallel from a single range. The pumps of every pair of boilers are interconnected with one another, but not with any other pumps, and each pump can easily furnish sufficient water for two boilers at full steaming rate. The boilers will be fitted with chain grate stokers.

It was expected that the Bloom Street station would be running in time for the winter now passed, and the first instalment of generating plant has actually been warehoused since May, 1900, but the buildings are very greatly behindhand.

In conclusion, we tender our thanks to Mr. Wordingham for affording us facilities for inspecting and photographing the interesting apparatus described above, as well as for his kind assistance in the preparation of this article.

NOTES.

Electricity Works Statistics.—Our readers will receive with this issue of the Electrical Review our annual sheet of the statistics of alternating current electric lighting stations in the United Kingdom. The direct current sheet will probably accompany our issue of May 3rd.

Protection of Buildings from Lightning.—A Lightning Research Committee has been organised by the Royal Institute of British Architects and the Surveyors' Institution, with the object of collecting and tabulating information from all parts of the country as to damage resulting to buildings from lightning-stroke. The present inquiry by the collection of precise data, may serve to test in some measure the results accruing from the rules laid down by the Lightning-Rod Conference nearly 20 years ago. The Committee includes Mr. John Slater (chairman), Major-General E. R. Festing, C.B., F.R.S., Dr. Oliver Lodge, F.R.S., Messrs. J. Gavey, W. P. Goulding, W. N. Shaw, F.R.S., H. H. Statham, A. R. Stenning, Arthur Vernon, Killingworth Hedges, C.E. (hon. secretary). In pursuance of their inquiry the Committee seek the co-operation of competent observers in all parts of the country, with a view to obtaining accurate details, noted on the spot, of the effect of lightning strokes on buildings, whether fitted with conductors or not. A schedule of questions will be sent to persons willing to act as observers. Such persons should communicate with the Secretary to the Committee at the offices of the Royal Institute of British Architects, 9, Conduit Street, London, W.

Aluminium "Paper."—The last craze of our irresponsible press, is that aluminium will shortly displace paper as the substance on which they print their masterpieces of literature and fiction. The advantages claimed for the metal are lightness, aseptic properties coupled with facilities for disinfection, and permanence; the only objection being the cost. Curiously enough, were the scheme feasible, the cost would be an advantage, and the permanence a defect; for the former, we would fain hope, would reduce the number of fatuous periodicals issued, and the second would hand down to our posterity an even unnecessarily bad opinion of the intellectual calibre of the inhabitants of the globe at the beginning of the 20th century. Seriously speaking, there would be no particular difficulty in rolling aluminium down to the thickness of good quality paper in small pieces, but we scarcely understand how rolls two or three yards wide and several miles long, such as are nightly consumed in Fleet Street, are to be prepared. Moreover, there remains the question of legibility, for we have not yet seen sheet aluminium manufactured with such a surface that ordinary printers' ink would show up on it as distinctly as on paper. We observe that one of our contemporaries is so much enamoured of this new idea, or so alarmed at the dismal prospects of the paper market, that it has actually taken the trouble to interview the British Aluminium Company on the subject, learning that the cost of thin aluminium foil would be from 20 to 30 times that of paper of high quality. It might also be added that the cost of printing on aluminium, or rather of the ink required for printing on it, would be increased four or five times over and above the extra expense of the "paper" itself. We have sometimes wondered why aluminium has not been recommended as a substitute for lead in clock weights, and we humbly offer the suggestion to our friends of the half-penny press.

New Journals.—Two new electrical publications have recently been started in London. *Electrical Investments*, a penny fortnightly, is, as its name implies, a financial record of electrical undertakings. It is published by the Manual of Electrical Undertakings, Limited, of Norfolk Street, W.C., who are also responsible for Mr. Garcke's well known manual. A market report and share list of electrical companies, comments on City meetings, and an article devoted to some particular electrical industrial company have been the main features of each of the first three numbers.

The second publication is altogether of a different character—we refer to *Traction and Transmission*. While purporting to be a monthly supplement to *Engineering*, which doubtless finds the demand among its readers for electrical engineering knowledge quite irresistible, the new journal is sold at 2s. per copy, and bears more the appearance of a distinct electrical publication of the magazine order. Among the articles appearing in the first number (April), are contributions from Mr. H. F. Parshall on "Standardisation of Electrical Apparatus," Mr. B. A. Raworth on "The Education of the Electrical Engineer," Mr. A. H. Gibbings on "The Conveyance of Goods on Electric Trolley Lines;" other subjects dealt with being multiple unit systems, electric tramway practice in Switzerland, St. Lawrence power station, radial axles for electrically driven vehicles, &c.

We wish our two new contemporaries the success they deserve.

Our Electric Railways.—We have set the whole world many valuable object lessons in the matter of underground electric railways. When so much is being said about what somebody else has done, English electrical engineers must not forget to rub this home. It is interesting to learn that a commission of engineers is to be sent to England by the Belgian Government to study our system of electrical railways.

Lectures.—On Friday last Mr. W. Wyld lectured to the members of the Engineering Society associated with the Coventry Technical Institute, on "The Electrical Distribution of Power in Factories." The lecture was illustrated by lantern views.

On Monday, before the Ipswich Engineering Society, Mr. James Hall read a paper on "The Evolution of the Modern Dynamo."

Cost of Power for Electric Railways. — The *Street Railway Review* recently published the following table, showing the cost of power for certain electric railways :—

Output Measured by Wattmeter in each Case.

	Station.	Month. 1900.	Monthly output, kw.-hours.	Cost of electrical output per kw.-hour—Cents.						Gals. cylinder oil per 10,000 kw.-h.	Gals. lubricating oil per 10,000 kw.-h.	Lb. water per lb. coal.	Lb. fuel per kw.-h.	Price of fuel per ton of 2,000 lbs.	Kind of fuel.
				Fuel.	Labour.	Supplies, oil, waste, &c.	Water.	Repairs	To'al.						
1	... ...	Nov.	2,109,400	·337	·119	·031	·030	·052	·579	2·69	·99	11·05	2·49	$2.51	Bituminous
1	... ...	Dec.	2,335,200	·346	·115	·039	·028	·057	·585	2·50	·89	10·96	2·41	2·87	"
5	Metropolitan Elevated, Chicago...	Nov.	2,002,596	·434	·131	·017	·015	·051	·648	2·71	1·52	5·32	4·57	1·92	"
6	"	Dec.	2,102,916	·451	·127	·016	·013	·034	·641	2·95	1·23	5·23	4·63	1·95	"

Personal.—Mr. R. Humphries has been appointed resident engineer to the Isle of Thanet Electric Tramways and Lighting Company, Limited. Mr. Humphries has been with the Dublin United Tramways Company as chief assistant for five years, and was formerly at the Bankside station of the City of London Electric Lighting Company.

The Postmaster-General has notified his approval of the promotion of Mr. George Tose to be chief superintendent of the telegraph branch of the service at Liverpool, in succession to Mr. Joseph Ismay, who was recently promoted to the assistant postmastership.

Mr. W. B. Woodhouse has been appointed chief electrical assistant to the Newcastle-upon-Tyne Electric Supply Company, at their Neptune Bank power station.

It is announced that the King has, on the recommendation of the Secretary for Scotland, approved of the appointment of Mr. T. Hudson Beare, now Professor of Mechanical Engineering at University College, London, to the Chair of Engineering in the University of Edinburgh, in succession to the late Prof. Armstrong.

Mr. Will. M. Furniss, who for the past nine years has been with Messrs. J. C. Howell, Limited, has joined the staff of Messrs. Handley & Shanks, of Birmingham, Dublin, Cork, and London.

Mr. O. Dewey has resigned his position under the Manchester Corporation, having been appointed assistant engineer to the Notting Hill Electric Lighting Company, Limited. He has held the position of distributing station assistant at Manchester during the past 18 months, and has supervised the erection and setting to work of the H.P. continuous current and three-phase sub-station plant, of which the description is concluded in this issue.

Mr. F. H. Davies has been appointed managing engineer at the Lewes station of the Electrical Power Distribution Company.

The Coventry Electric Light Committee has appointed Mr. Jeckell, of South Shields, manager of the electric light works, at a salary of £350 per annum.

Mr. Alfred Hay, who has lately received the D.Sc. Degree in "Engineering Science" from Edinburgh University, and who was Lecturer on Electro-Technology at Liverpool University College, has just been appointed professor of the same subject at the Royal Indian Engineering College, Cooper's Hill. Dr. Hay was one of Prof. Andrew Jamieson's old students and assistants at the College of Science and Art, Glasgow.

The Yorkshire and South Yorkshire Electric Power Bills.—On Wednesday night a special meeting was held of the Halifax and District Chamber of Commerce, Alderman Smithies presiding, to decide what action should be taken with regard to the above Bills, which reach the Committee stage in the House of Commons on the 24th inst. The Halifax Town Council have already lodged petitions against both Bills, but have at the same time made the fact known that of the two measures they prefer that of the South Yorkshire Company. The meeting was presided over by Alderman Smithies, the president, who pointed out that the Yorkshire Electric Power Company had issued a circular announcing that they had decided to incorporate in their Bill the schedule of prices incorporated in the South Yorkshire Bill. The absence of this schedule from the Yorkshire Bill led them at their previous meeting to prefer the South Yorkshire. Mr. T. S. Scarborough thought the South Yorkshire Bill was the best. Mr. James Tattersall moved, and Mr. Bold L. Fletcher seconded, "That the maximum charges—4d. per unit—in both Bills are much too high, and we cannot support either Bill on that account." This was passed unanimously. It was mentioned during the discussion that the two companies would very likely amalgamate; rumours were afloat that negotiations with this end in view were now proceeding.

The Explosion Fatality at Marylebone.—The inquest to which we referred last week, into the death of a boiler-cleaner in the employ of the Metropolitan Electric Supply Company, was concluded on 12th inst. The explosion which occurred at the Marylebone generating station was due to the bursting of a superheater pipe. Mr. Arthur Wyatt, superintendent at the works, said that he had failed to detect any flaw in the pipe, which was now in the hands of Board of Trade officials. The pipe should have borne a much greater pressure than there was upon it. The occurrence was a mystery to him. In the result the jury found a verdict of "Accidental Death," and added, "The jurors would suggest for the consideration of the company the advisability of providing a safer means of egress from the stokehole of the new boiler house. They are further of opinion that the witness Taylor, before going to the old boiler house to shut off the steam, should have told the deceased and the other men to leave the stokehole." But for this error of judgment, the Coroner remarked, Taylor had acted properly as well as promptly.

Obituary.—The death is announced of Lady Siemens, widow of Sir William Siemens, F.R.S.

Mr. Thomas Spencer, of the firm of John Spencer & Sons, of Newburn Steelworks, Newcastle-on-Tyne, died last Friday after an illness of some months. Mr. Spencer was the third and youngest son of the late Mr. John Spencer; the founder of the steelworks at Newburn, and was in his 76th year.

We regret to learn of the death of Mr. Douglas Rickard, which occurred on the 14th inst. Arrangements have been made for the business to be continued at Ashbourne Road Mills, Derby, by his widow, with the assistance of the present staff. The style of the firm will continue to be as heretofore.

Institution of Electrical Engineers (Dublin Section).—At the meeting held at Dublin yesterday (Thursday), the following papers were read:—"Sources of Electro-Magnetic Vibrations," by F. T. Trouton, D.Sc., F.R.S., member; "Notes on a Humming Telephone," by F. Gill, member.

Appointments Vacant.—The Poplar Borough Council wants certain assistants for its electricity works clerical department. The Sutton Coldfield Corporation requires a resident electrical engineer at £200 per annum.

The Institution of Junior Engineers.—The provisional programme of the Summer Excursion, 1901, has been issued. The date is August 10th—17th, and the places of meeting Plymouth and Devonport.

Where the Present Generation Scores.—Thus the *Daily Mail*, on Monday last, referred to the issue of a new loan of £400,000 by the West Ham Corporation. In its leader it argues that in the supply of water and gas it is not unreasonable that our municipalities should go into trade and compete with private enterprise, but it warns them that if they engage in industry and sink large sums of capital, it is vital that the industry should be remunerative. Further, there is always a temptation, where such undertakings are not remunerative, to hide the fact by making inadequate allowance for the depreciation of plant, and it cites electricity supply as an example. It is said by expert critics that in numerous instances the sum allowed by municipalities for depreciation is absurdly below the necessities of the case. Machinery goes out of date and is worn out with startling rapidity, especially where it is electric; in other words, the "antiquation factor" is high, and is seldom sufficiently considered. If proper allowance is not made for renewal—or scrapping of obsolete types of plant, which is a slightly different thing—it may, as our friendly critic says, easily be the case that electricity is being supplied to the present generation under cost, at the expense of posterity. At the same time, in 18, 22, or 42 years, the loans by which the capital to purchase it was obtained will have been paid off, and further loans for new machinery could be raised. This does not, however, excuse an ostrich-like policy by which present-day councillors reap a temporary and transient notoriety, leaving to future chairmen and committees the footing of the inevitable bill. Nor does it render the financial policy sound that would save the face of the lighting or sanitary rate demand note, where electrical energy is sold for street lighting purposes so "cheap," that the expenses of producing it have to be put on other shoulders, perhaps less able to bear the burden.

Calcium Carbide in Australia.—It is reported that an Australian company is making arrangements to erect a carbide factory at Adelaide which will be driven by the gases from the coke ovens near there. A project of the same kind relating to South Queensland will be studied later on when the former works is in operation.

The Westinghouse Works.—The British Westinghouse Electric and Manufacturing Company, Limited, have acquired a further 25 acres of land from the Trafford Park Estates, Limited. The area of land they have purchased in Trafford Park is now about 100 acres.

Manchester Electric Trams.—The Electricity Committee has made arrangements by which it hopes to supply power for running the first three routes of electric trams before June 1st this year, and all other routes by May, 1902.

City and Guilds of London Institute.—His Majesty the King has graciously consented to become patron of the City and Guilds of London Institute, of which, as Prince of Wales, he has been President since 1881.

Institution of Electrical Engineers.—The list of nominations for the Council for 1901—2, which was laid before the meeting last night, is as follows:—

President:—Mr. W. Langdon.

Vice-Presidents: Mr. R. K. Gray, Major P. Cardew, R.E.,* Messrs. S. Z. de Ferranti,* and J. Gavey.*

Members of Council:—Messrs. H. H. Cunynghame, C.B., H. Edmunds, R. Hammond, H. Hirst, J. E. Kingsbury, A. J. Lawson, R. P. Sellon, C. P. Sparks, H. E. Harrison,* Lieut.-Col. H. C. L. Holden, R.A., F.R.S.,* Hon. C. A. Parsons, F.R.S.,* Messrs. W. H. Patchell,* J. H. Rider,* M. Robinson,* and J. Swinburne.*

Associate Members of Council:—W. R. Cooper, M.A., B.Sc.; R. W. Wallace, K.C.; and W. Duddell.*

Hon. Auditors:—Messrs. F. C. Danvers and E. Garcke.

Hon. Treasurer:—Prof. W. E. Ayrton, F.R.S. (Past-President.)

Hon. Solicitors:—Messrs. Wilson, Bristows and Carpmael.

* New nomination.

Destruction of Water Pipes in New York.—The large amount of water supplied to the water mains in New York City (says the *Street Railway Journal*) has led the authorities to believe that there were serious leaks in the service mains. That this is true is shown by an accidental discovery during March in lower New York, where it was found that in one place some 20,000 gallons daily were escaping through a defective pipe, and subsequent examination has shown a great deterioration in the water pipes in this section of the city, and countless leaks. Indeed, it is thought that more than half of the water supply of the city escapes through defective pipes. The preceding remarks read very much like the introduction to a paper presented before an association of the water companies as the preliminary to an attempt to charge up the destruction of the pipes to electrolysis caused by the rail return circuit of the local trolley company. This plan would undoubtedly have been promptly followed in New York City by the electrolytic enthusiasts, except that, unfortunately, all the lines on Manhattan Island use a complete metallic return, and also that the most serious leak is very far distant from an electric railway line of any kind. It is a curious fact that deterioration of water pipes from natural causes seems to cease immediately upon the introduction of a trolley system, and the return circuit just as promptly commences its fell work. We hope (says our contemporary) that the New York example, however, will show that water pipes do occasionally give out from causes other than those of the return circuit.

NEW COMPANY REGISTERED.

Maund & Robson, Limited (69,781).—This company was registered on April 6th, with a capital of £10,000 in £5 shares, to carry on the business of carrier of passengers and goods, electrical engineers, contractors, manufacturers of and dealers in railway, tramway, electric, magnetic, galvanic and other apparatus, mechanical and chemical engineers, generators, accumulators, transmitters, users and suppliers of light, heat, sound, and power by electricity, galvanism, magnetism, compressed air, gas, steam, oil or otherwise, &c. The first subscribers (each with one share) are:—A. Maund, 24, Scarisbrick Street, Southport, electrical engineer; W. H. Robson, 53, Arbour Street, Southport, electrician; Mrs. L. B. Robson, 53, Arbour Street, Southport; Mrs. K. P. Maund, 24, Scarisbrick Street, Southport; J. Graham, 23, King Street, Wigan, solicitor; J. B. Robb, St. Romans, The Park, Waterloo, Liverpool, electrician; and T. Gould, 47, Manchester Road, Denton, hosiery manufacturer. No initial public issue. The number of directors is not to be less than three nor more than seven. The subscribers are to appoint the first; qualification, £50; remuneration as fixed by the company.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

Crystal Palace District Electric Supply Company, Limited (18,532).—This company's annual return was filed on April 4th, when 47,859 shares were taken up out of a nominal capital of £75,000 in 75,000 shares of £1 each. £1 has been called up on each of 2,859 shares, resulting in the receipt of £2,859. £45,000 is considered as paid on the remainder. Mortgages and charges, £50,000.

Yorkshire Electric Power Syndicate Limited (67,574).—This company's annual return was filed on March 12th, when the entire capital of £10,000 in 100 shares of £100 each had been taken up. £35 per share has been called up, resulting in the receipt of £3,500. No mortgages or charges.

W. T. Henley's Telegraph Works Company, Limited (13,795).—This company's annual return was filed on March 21st, when 35,000 preference, and 35,000 ordinary shares were taken up out of a nominal capital of £400,000 in 40,000 preference, and 40,000 ordinary shares of £5 each. £5 has been called up on each of 35,000 preference, and 29,000 ordinary shares, resulting in the receipt of £320,000. 6,000 ordinary shares are considered as fully paid. Mortgages and charges—£50,000, less £950 transferred to trustees = £49,050.

National Telephone Company, Limited (15,066).—This company's annual return was filed on March 21st, when 15,000 first preference, 15,000 second preference, 250,000 third preference, 590,000 ordinary shares were taken up out of a nominal capital of £6,000,000 in 15,000 first preference, 15,000 second preference, 250,000 third preference, and 890,000 ordinary shares of £10 each; £10 has been called up on each of the first and second preference, and £5 on each of 221,716 third preference and 545,587 ordinary shares, resulting in the receipt of £4,136,515; £363,485 is considered as paid on 44,413 ordinary and 28,284 third preference shares. Mortgages and charges, £2,500,000.

SUPPLY STATION ACCOUNTS.

Newport Corporation Electricity Accounts.

The electricity department of the Newport Corporation is making steady progress. The lamps added to the mains annually average 6,000 to 7,000, but the units have shown an increase of nearly double that of the two years previous to those given below. In 1899 the corner was turned, and instead of a loss a net profit is shown after meeting all charges, a result which must be altogether encouraging to Mr. C. D. Copland, the borough electrical engineer, and Mr. J. G. Ellis, the commercial manager.

GENERAL STATEMENT.

	1898.	1899.	Increase.
Total capital expenditure ...	£65,699	£88,802	£23,103
Number of units sold	322,638	469,204	146,566
Number of lamps connected ...	24,707	31,273	6,566
Maximum load in KW.	392	506	114
Gross revenue	£5,834	£8,252	£2,418
Gross expenditure...	£3,491	£4,160	£669
Gross profit	£2,343	£4,092	£1,749
Average price per unit sold ...	4·20d.	4·08d.	—·12d.

The rates charged at Newport are 6d. and 4d. for private supply, and 2d. and 1½d. for power and heating; a fixed charge of £20 per annum each being made for 76 public arc lamps. The revenue account shows a drop of about ½d. per unit.

REVENUE STATEMENT.

	1898. Gross.	1898. Per unit.	1899. Gross.	1899. Per unit.	Increase.
Sale of energy	£5,643	4·20d.	£7,982	4·08d.	—·12d.
Meter rents	191	·14d.	270	·14d.	·00d.
Sale of materials and lamps ..	—	—	—	—	—
Sundry fees, &c.	—	—	—	—	—
Gross revenue ...	£5,834	4·34d.	£8,252	4·22d.	—·12d.

With the exception of repairs, all the items on the cost sheet have been reduced per unit, giving an improvement of $\frac{3}{10}$d. on the works cost, and nearly ½d. on the total cost, which now stands at 2½d. The figures for management and establishment charges are taken together, details not having been given us of these or of the amounts expended on the street lighting.

COST OF PRODUCTION.

	1898. Gross.	1898. Per unit.	1899. Gross.	1899. Per unit.	Increase.
Coal, and cartage of same ..	£900	·67d.	£1,070	·55d.	—·12d.
Oil, waste, water and engine room stores	277	·20d.	293	·15d.	—·05d.
Salaries and wages incurred in generation and distribution	990	·74d.	1,081	·55d.	—·19d.
Repairs and maintenance buildings, boilers, engines, dynamos, &c.	89	·07d.	255	·13d.	+·06d.
Works cost ...	£2,256	1·68d.	£2,699	1·38d.	—·30d.
Rent, rates and taxes ..	182	·13d.	179	·09d.	—·04d.
Management expenses, salaries of managing engineer, secretary, clerks, &c.	1,053	·78d.	1,282	·66d.	—·12d.
General establishment charges, stationery and printing, law charges and insurance					
Other expenses	—	—	—	—	—
Total costs ...	£3,491	2·59d.	£4,160	2·13d.	—·46d.

The financial charges in 1898 were £2,636, and in 1899 £3,689, an increase of £1,053. The gross profit had, however, risen by £1,749, or by £696 more than the sum required for interest, &c. The loss of £293 in 1898 has by this means been converted into a net profit of £403. This improvement is largely due to more economical generation, coupled with an improved load factor, for the additional output was not accompanied by a proportionate increase in the maximum demand.

PROFIT STATEMENT.

	1898.	1899.
Interest on loans	£1,560	£2,573
Sinking fund for repayments	1,076	1,116
Net profit carried forward	—293	403
Gross profit	£2,343	£4,092

Kensington and Knightsbridge Electricity Accounts.

In our issue of February 15th last, we gave a report of the 14th annual general meeting of the Kensington and Knightsbridge Electric Lighting Company, and we now analyse the figures for the last two years' accounts. Those for 1900 cover a transition period owing to a small portion of the energy sold being generated at the new joint station of this and the Notting Hill Company at Wood Lane. This new works is now almost in full working order, and we hope it will realise the expectations formed as to the economy and convenience resulting from its establishment.

GENERAL STATEMENT.

	1899.	1900.	Increase.
Total capital expenditure ...	£273,814	£312,449	£38,635
Number of units sold	2,463,950	2,630,482	166,532
Number of lamps connected ...	183,462	199,098	15,636
Maximum load in KW.	2,031	2,350	319
Gross revenue	£53,173	£55,200	£2,027
Gross expenditure	£28,652	£29,032	£380
Gross profit	£24,521	£26,168	£1,647
Average price per unit sold ...	4·93d.	4·80d.	—·13d.

The prices charged for energy are 6d. for lighting at 100 v., 5d. for lighting at 200 v., and 4d. per unit for power and heating, the average receipts per unit being last year 4½d., a reduction of about ½d. on the previous year. Meter rents and sundry fees bring the total to just over 5d. The increases in revenue and in output are not large, but the period immediately preceding the opening of the new works could not be expected to show any great development of the undertaking.

REVENUE STATEMENT.

	1899. Gross.	1899. Per unit.	1900. Gross.	1900. Per unit.	Increase.
Sale of energy..	£50,655	4·93d.	£52,601	4·80d.	—·13d.
Meter rents	1,596	·16d.	1,712	·16d.	·00d.
Sale and repairs of lamps, &c.	14	·00d.	8	·00d.	·00d.
Sundry rents, trnsf'r fees, &c.	908	·09d.	879	08d.	—·01d.
Gross revenue ...	£53,173	5·18d.	£55,200	5·04d.	—·14d.

The chairman of the company stated at the annual meeting that the expenses seemed excessive compared to the increased amount of electrical energy sold, but explained that coal had cost £2,000 more than in 1899, and it happened that the last three months of the year were unusually light and free from fog. This increase in the fuel item represented over ½d. per unit, bringing the figure up to nearly ½d. per unit. Omitting those items whose changes cancel out, repairs have dropped substantially—nearly ¾d.—and the difference, —·29 + ·15, equals —·14, which appears as the alteration in the total cost.

COST OF PRODUCTION.

	1899. Gross.	1899. Per unit.	1900. Gross.	1900. Per unit.	Increase.
Coal and unloading, &c. ..	£6,559	·64d.	£8,604	·79d.	+·15d.
Oil, waste, water, and engine room stores.	907	·09d.	915	·08d.	—·01d.
Salaries and wages incurred in generation and distribution.	3,687	·36d.	3,695	·34d.	—·02d.
Repairs and maintenance of engines, boilers, buildings, dynamos, &c.	8,769	·85d.	6,183	·56d.	—·29d.
Electricity supplied from Wood Lane works	—	—	132	·01d.	+·01d.
Works costs ...	£19,922	1·94d.	£19,529	1·78d.	—·16d.
Rent, rates and taxes ..	4,036	·40d.	4,683	·43d.	+·03d.
Management expenses, salaries of managing engineer, secretary, clerks, &c., directors' and auditors' fees	3,226	·31d.	3,495	·32d.	+·01d.
Establishment charges, stationery and printing, law charges and insurance	1,408	·14d.	1,325	·12d.	—·02d.
Other expenses	—	—	—	—	—
Total costs ...	£28,652	2·79d.	£29,032	2·65d.	—·14d.

The financial position is given in detail below, but it may be explained further thus:—

Year.	Sum available.	Appropriated or available for dividends.
1898 (brought forward from)...	£1,225 ...	—
1899	9,072 ...	£5,800
1900	14,255 ...	18,752
	£24,552	£24,552

And in each year the general distribution of the net profit was:—

	1899.	1900.
Interest	£3,536 ...	£3,619
Depreciation and renewals, &c.	5,202 ...	8,294
Dividends	15,763 ...	14,255
Gross	£24,521 ...	£26,168

The actual allocation for 1900 was a payment of dividend of 12 per cent., and carrying forward from the above sum available an amount of £4,700.

PROFIT STATEMENT.

	1899.	1900.
Interest on debentures, calls, deposits and loans ..	£3,556	£3,619
Net profit carried to dividends..	6,691	14,255
" " 200-volt conversion	147	409
" " depreciation account	290	290
" " renewal account..	4,765	7,595
" " forward	9,072	—
Gross profit	£24,521	£26,168

CITY NOTES.

Dudley, Stourbridge and District Electric Traction Company.

THE annual meeting of the above company was held at Donnington House, Norfolk Street, W.C., on Wednesday afternoon, Mr. C. S. B. Hilton presiding.

In moving the adoption of the report, the CHAIRMAN said the share capital was fully issued, the total capital being now £200,000. The balance payable to the British Electric Traction Company was now only very small. The depreciation fund had been increased by £1,000. The profit and loss account this year was appreciably better than last year. They brought forward from last year's account £2,313, and the profit for the year was £6,920, making altogether £9,214, and after deducting the dividend to the preference shareholders there was left £8,511 7s. 9d. On the other side they had a capital outlay on the old lines reconstructed of £59,136, which was a slight increase over the previous year. For the reconstruction of the old lines the account was now £159,348, and £26,039 had been expended during the year. In the profit and loss account the running expenses had increased very considerably and were £8,874 this year. That was accounted for to a great extent by the opening of the new lines, and also, no doubt, by the increase in the price of fuel, and therefore they might look forward to rather better results in that direction in the present year. Maintenance and repairs were slightly lower, and the administrative and general expenses slightly higher. The traffic receipts were £18,290 as against £11,000 last year, due mainly to the opening of new lines. The Cradley line was opened in October and the Kingswinford line in December. The board had every reason to be satisfied with the results so far, and anticipated during the present year not only maintaining the results, but improving on them. They proposed to place £2,000 to a sinking fund, which would be invested outside the business, and which would give security to the shareholders for the future. They would place £1,500 to depreciation, as against £1,000 last year, making that fund £7,579. They also proposed to pay 4 per cent. on 11,789 ordinary shares of £5 each, and on the 8,211 shares allotted to the British Electric Traction Company. The line through High Street, Stourbridge, was nearly completed, and would be opened in a few weeks. The directors had therefore decided that the wise thing to do would be to go forward with the extension of this line to the Lye, and when that was done they hoped they would have seen the end of their capital expenditure for some little time. To provide for this additional expenditure, and anything still due under the old contracts, the board proposed to issue debentures, or debenture stock, as the case might be, and they hoped that an issue of £60,000 would cover all their needs. The chairman proceeded to refer to the adjoining lines, viz., the Wolverhampton and Bilston line, and the Birmingham and Wednesbury line, which he said would act as feeders to their lines. The latter line would shortly be electrified, and in every direction the outlook was favourable for the coming year.

Mr. R. PERCY SELLON seconded the motion, and it was agreed to.

Subsequently a resolution was passed agreeing to join the British Electric Traction superannuation fund for employés.

Blackheath and Greenwich District Electric Light Company.

SIR JOHN A. WILLOX, M.P., presided on Wednesday afternoon over the third general meeting of the above company, and in moving the adoption of the report, he said the report and accounts dealt with a period of 15 months, but now that the company was in working order, and the accounts had been brought into unison with the calendar year, the directors could in future present their financial statement for each complete 12 months, ending December 31st. Disappointment had been experienced in the completion of the machinery at the generating station. They had hoped that the works would be ready for use in October or November, and that they should thus have the advantage of a good demand in the winter season. As a matter of fact, however, they were unable to begin the supply of current from their own station until the middle of February, when the winter demand had passed. They recovered the sum of £1,200 from the contractors for the delay in finishing their work, but this was a poor equivalent for the loss of business the delay caused. They deemed it prudent to postpone the commencement of the supply until the station was in efficient order rather than begin prematurely, with the risk of a breakdown. This cautious policy had been rewarded with satisfactory results. Since the supply began on February 14th, it had been maintained without failure or interruption, and had given reasonable satisfaction to consumers. It had also established public confidence in the stability and resources of the company and convinced residents and tradesmen that they could depend on a reliable and effective service from the company's mains. This feeling of confidence was proved in the most tangible and convincing way, viz., in the number of consumers and the increase in their demands. The company commenced its own supply in February with 132 consumers, with the equivalent of 5,957 lamps connected, and at the close of the year the number of consumers had risen to 342, and the lamps connected to 14,473. This progress still continued. On April 1st the number of lamps connected had further increased to 16,520, and there were new applicants waiting to be connected to the equivalent of 4,907 lamps. It was a favourable augury that the company, in the first year of its operations, should have no less than 21,500 lamps connected or applied for. It suggested that the prospects of early success were excellent. The figures quoted related almost exclusively to the supply of current for illumination, but there was a hopeful prospect in the supply of energy for purposes of power. In the Greenwich district there were many industrial and manufacturing concerns which would find it convenient and economical to take their supply power from the company's station. Some large contracts of this description had been negotiated, and there was every reason to anticipate that they would soon have a good day load for power as well as a good load at night for light. This would enable them to run the generating station under favourable conditions. It will augment the revenue without entailing any material increase in the working charges. The areas served by the company is very extensive, and building operations are in rapid progress. The adoption of the free light installation system had proved advantageous in attracting consumers. Their experience was that once the light was introduced the lamps were soon extended beyond the original grant of six free lights. The financial results of their brief experience cannot be deemed unsatisfactory. It is no small achievement to come out of the first year's working of an electric light company on an even keel. That was their good fortune. The profit on the working is £144; this result was attained under very adverse conditions, and they might safely reckon that the current year would yield a more substantial margin of profit. Indeed, they had assurance of this in the working for the quarter that had passed since the report was made up. There was an increased demand both for light and power, and this increase steadily continued. As the works cost would not advance in the same ratio, and as the price of fuel had fallen considerably, the directors were sanguine that next year's balance-sheet would prove acceptable to the proprietors.

Mr. H. W. BOWDEN (managing director) seconded the motion.

Replying to a number of questions, the CHAIRMAN said the board had made arrangements for pushing the business. In future all details would be supplied with regard to the cost per unit of electricity, &c. They had already connected one or two factories for the supply of electricity for power purposes. Nothing had yet been done with regard to the public lighting of the district, nor did the board think it wise to enter into large capital expenditure for the supply of electricity to tramways in the present state of the tenure of tramway companies in the locality.

The report was adopted.

Eastern Extension, Australasia and China Telegraph Company.

THE report for the half-year ended December 31st last, to be submitted to the meeting to be held on 24th inst., states that the gross receipts have amounted to £360,889, against £339,450 for the corresponding half-year of 1899. The working expenses, including £23,586 for maintenance of cables, absorb £104,640, against £116,935 for the corresponding period of 1899, leaving a balance of £256,249. From this is deducted income-tax, interest on debenture stock, donations to the Indian Famine and Foochow Flood Relief Funds, and £1,500 for a testimonial to the late chairman, as recommended by the shareholders, leaving as net profit £242,029. After adding £16,833 brought forward, there is an available balance of £258,862. One quarterly interim dividend of 1¼ per cent. has been paid for the half-year, and it is now proposed to distribute another of like amount, making, with the interim dividends paid for the first half-year, a total dividend of 5 per cent. It is also proposed to pay a bonus of 4s. per share, or 2 per cent., making a total distribution of 7 per cent. for 1900, leaving a balance of £146,362. After deducting £4,880 towards providing the agreed dividend on the new issue of shares, there remains £141,482, which has been transferred to the general reserve fund. This fund has also been credited with the premium of £150,000 received on the new issue of shares, and debited with £125,137, the amount of expenditure to date on the Cape-Australian cable. The company, in conjunction with the Great Northern Telegraph Company, has constructed landlines between Taku, Tientsin, and Pekin, in connection with the international cables recently established by them to the north of Shanghai. These landlines have been opened to the public without any additional charge being made on telegrams exchanged between Europe and China. The "standard revenue" fixed by the Cape-Australian cable agreement for regulating the Australasian tariffs having been maintained during the past year, further reductions of rates were brought into force on January 1st last for telegrams exchanged with South Australia, Western Australia, and Tasmania. The Government of New South Wales has since accepted the agreement, and the reduced rates were applied to telegrams exchanged with that

State as from February 1st last. The ss. *Anglia*, with the first section of the Cape-Australian cable—namely, between Durban and Mauritius—left the Thames for Natal on the 29th ult. A contract has been entered into with the Netherlands Indian Government for supplying and laying, on account of that Government, a cable between Java and Borneo. The cable is now being manufactured, and is expected to be laid during the current half-year.

Elmore's German and Austro-Hungarian Metal Company.

The annual report of the directors for the year ending December 31st, 1900, reads as follows:—

The directors have pleasure in submitting herewith the accounts of this company and those of the "Metall" Company, made up to December 31st, 1900. The only alteration in the capital of the former company is the increase in the number of preference shares by 3,606, issued in June last, part of 5,000 offered to the shareholders for subscription. The amount of the loan to the "Metall" Company shows a reduction, owing to the transfer of the sum of M. 400,000 to share account. The items in the profit and loss account require little explanation. Directors' fees show a reduction, owing to an arrangement whereby the "Metall" Company is to pay a moiety. The item, £5,996 18s., for debenture interest, shows an increase of £495 2s. 11d. upon that for 1899. The directors regret that, owing to the serious financial condition of Austria and Hungary, they were unable to make any arrangement for the disposal of the patents in those countries.

The figures, with regard to the "Metall" Company, may be regarded with satisfaction, as the trading profit shows an increase of no less than M. 84,331.84, in spite of the greatly increased cost of both materials and wages. There was a considerable increase in both output and sales, notwithstanding the fact that the new plant did not come into operation until late in the year. In the profit and loss account will be noted the items "law charges, &c., on increase of capital," and "taxes." The former is not a recurring charge, and, with regard to the latter, the authorities have now consented to a considerable reduction, and have, in fact, remitted a portion of the amount shown in the balance-sheet. The item "general expenses," includes one-half the cost of the company's exhibit at Paris. The cost of repairs and maintenance shows an increase of M. 8,081.85 over that for the previous year, on account of the alteration of a number of original tanks to the latest design, the entire cost of which was charged to revenue.

As the shareholders have already been informed, the company was awarded the gold medal at the Paris Exhibition. It is gratifying to know that, although trade in Germany is not considered good, the factory is fully engaged in executing remunerative orders. Arrangements are being made with a view to the construction of a full-gauge railway line from the main line into the factory. This extension will prove of great value, apart from the saving of transport charges to the station, which are now heavy.

The directors have the financial position of the company always before them, and now that the value of the Elmore process has been fully proved, it is the only difficult problem left for solution. The debenture stock falls due for redemption on July 1st next, and the directors rely upon the assistance of both stock and shareholders in making a proposed new issue of 6 per cent. stock a success. In view of the fact that copper stores and book debts show an increase of M. 312,388.83 (£15,619 8s. 9d.) as compared with the previous year, and also that the weekly output up to date averages nearly 24 tons per week, it is manifest that more capital is required, and it is therefore desirable to increase the amount of the debenture stock to £100,000, and a resolution will be proposed, giving the directors the necessary power to do this. Of the 5,000 preference shares offered to the shareholders last year, 3,606 were taken up: the balance, 1,394 will be again offered for subscription. After setting aside the usual reserve, the directors of the "Metall" Company have declared a dividend equal to M. 160,000, or £7,804 17s. 6d., from which has to be deducted the amount of the balance of charges of the Austrian Company for the past year, amounting to £1,504 8s. 6d. From the balance the directors recommend the payment of a dividend of 5 per cent., or 2s. per share, less tax, to the preference shareholders, carrying forward £208 17s. 6d. The directors also recommend the payment of a dividend of 1½ per cent., or 3d. per share, free of tax, to the ordinary shareholders. The retiring director on this occasion, Mr. Charles Garnett, being eligible, offers himself for re-election. The auditors, Messrs. Cooper Bros. and Co., also offer themselves for re-election.

The annual meeting will be held at Winchester House on Monday, April 29th, at 3 o'clock. A resolution will be submitted authorising the directors to borrow £100,000 debentures or debenture stock.

The Great Northern Telegraph Company (of Copenhagen).

The revenue account for the year 1900 shows receipts as follows:—Balance on December 31st, 1899, £64,319 10s. 1d.; traffic receipts, £560,314 18s. 6d.; less loss on exchange, £23,965 17s. 9d.—£536,349 0s. 9d.; interest, £3,756 14s. 9d.; sundries, £11,939 2s. 6d = £616,364 8s. 1d.

Expenses:—Salaries and wages, £59,903 6s. 9d.; expenses of stations, offices and agencies, £7,490 18s. 11d.; ordinary supervision, and maintenance of sea and landlines, and repairing steamers, *H. C. Orsted* and *Store Nordiske*, £14,204 5s. 2d.; instruments and cells, £2,432 18s. 4d.; maintenance of company's buildings, £905 12s. 10d.; rates and taxes, £7,487 11s. 4d.; travelling expenses, £1,306 8s. 3d.; bank commission, &c., £2,735 14s.; sundries, £630 7s. 6d.; total expenses = £97,097 3s. 1d.

The board propose to distribute the balance as follows:—Interim dividends already paid, £75,000; final dividend proposed (£1 per £10 share), £150,000—£250,000; reserve and renewal fund, £166,666 13s. 4d.; renewal fund for cable steamers, £55,555 11s. 1d.; pension fund (staff), £5,555 11s. 1d.; directors' remuneration, £1,500; balance carried forward, £64,989 9s. 6d.—£519,267 5s. = £616,364 8s. 1d.

The German Atlantic Telegraph Company.

The result of the operations of the German Atlantic Telegraph Company during 1900 will be of interest at the present moment, says the *Financial Times*, in view of the prejudicial effect which has already been brought about in connection with the earnings of the English cable companies by the competition of this new service. At present the German company's paid-up capital amounts to £1,050,000, and of £200,000 yet to be issued a total of £142,000 stands at the disposal of the Eastern Telegraph Company and the Western Telegraph Company, for subscription at par value by virtue of agreements with regard to the transfer to the company, at the latest by 1904, of the cable from Borkum to Vigo, or of the shares held in the German Sea Telegraph Company. Although a preliminary start with the new cable was made on July 29th, it was not until September that working operations on the whole length of the cable belonging to the company were commenced, and between that time and the close of the year two interruptions took place extending over 27 days. The receipts of the company during the year comprised £15,351 from interest and £29,379 from the cable service, making a total of £52,130, including the balance from the previous year. After meeting expenses and providing for depreciation and renewal funds, there remains a net profit of £28,089, of which it is proposed to distribute £20,916 among the shareholders, by the payment of a dividend at the rate of 2 per cent., whilst the balance is absorbed by contributions to reserve fund and the next account. The company states that there have been two interruptions in the service during the present year.

Official Announcements re Companies.

The following companies have been struck off the register:—

Electric Horse Promotion Syndicate.
Freudenberg's Automatic Telephone Syndicate.
Freudenberg's Multiple Telephone Syndicate.
Improved Telephone Patents.
Premier Electricity Meter Company.
Vice Versâ Portable Electric Lamp Syndicate.
Water Powers and Industrial Estates Development Syndicate.
Whitstable Electric Light and Power Company.
William James Glover & Co. (Est. 1818).

The following are to be struck off within three months, unless sufficient reason is shown to the contrary:—

British Electro-Chemical Agency.
Economic Smoke Consumer.
Electric Hansom Cab and Carriage Company,
Electric Light and Power Company.
Electric, Limited.
Electric Metal-Working Syndicate.
Electric Night Advertising Company.
Elieson Electrical Switch.
General Electrical Company of Roumania.
Highland Water-Power Syndicate.
High-Power Electrolyte Syndicate.
Maxim Autocar Syndicate.
Maxim Carbide Process and Acetylene Gas Syndicate.
Peterborough Electric Light and Power Company.
Pioneer Electric Carriage Company.
Rollason's Wind Motor Company.
"Steady" Arc Lamp Company.
Telegraph Improvement Company.
Telephone Construction Company.
Town's Refuse Utilization Syndicate (Hanson's Patents).
Traction Syndicate.
Trehearne Electrical Engineering Company.
Universal Smokeless Furnace Company.
Wenlock Electrolytic Company.
Werner Cadmium Electric Accumulator Syndicate.

Indo-European Telegraph Company.

The directors' report for 1900 reads as follows:—

"The directors are still in negotiation with the Imperial German Government for an extension of the company's concession. The International Telegraph Conference, which was to be held in London in May of the current year, has been postponed until next year. The general tariff to Australia has been reduced from 4s. to 3s. 6d. per word for ordinary telegrams, which rate is now applicable to the Colonies of South and West Australia, New South Wales and Tasmania. The company has assented to bear its share of a reduction in the rate to India, which it is expected will be introduced before long. The lines of the company continue to work most efficiently, and both the Wheatstone and duplex systems continue to give satisfaction. The company's revenue from all sources for 1900 amounted to £151,643 11s. 4d., as compared with £142,343 4s. 2d. for 1899, showing an increase of £9,300 7s. 2d. The expenses were—on commercial and general account, £39,531 19s. 5d.; on maintenance account (expenses and charges) £38,827 6s. 6d.; total, £78,359 5s. 11d., as against £74,657 7s. 7d. for 1899, an increase of £3,701 18s. 4d. Deducting the above expenses of £78,359 5s. 11d. from the total revenue of £151,643 11s. 4d., a balance remains of £73,284 5s. 5d., from which income-tax paid, £3,560 2s. 5d., has to be deducted. To this the amount brought from the year 1899, £7,692 12s. 8d. has been added, and also a repayment by the Persian Government of £17,237 19s., making a total of £94,654 14s. 8d. From this amount £25,000 has been placed to reserve, and that sum, together with £10,625, amount of interim dividend, and a provision for depreciation of securities of £15,000 have to be deducted, leaving a balance of £44,029 14s. 8d. The directors now propose the declaration of a dividend for the six months ending December 31st of 17s. 6d. per share, making, with the dividend already paid, 6 per cent., and a bonus of 20s. per share, both free of income-tax, making in all 10 per cent. for the year, carrying forward £12,154 14s. 8d. to the credit of 1901. The following directors retire, and offer themselves for re-election:—L. Delbrück, Esq., and J. H. Tritton, Esq. In case any shareholder should be unable to attend the general meeting, he is requested to fill up and return the enclosed proxy form, duly signed, so as to reach the company's office not later than 12.30 p.m. on the 27th inst. Holders of shares to bearer must deposit their shares, with name and address, at the office of the company, 48 hours before the time appointed for the meeting, against an order of admission. The share warrants will be returned after the meeting. The transfer books will be closed from the 16th to the 30th inst., both inclusive. The auditors, Messrs. C F. Kemp, Sons & Co., chartered accountants, retire, and offer themselves for re-election."

Buenos Ayres and Belgrano Electric Tramways Company.

The report for 1900 states that the total receipts on revenue account amounted to £127,097 and the expenditure to £89,137, leaving a balance of £37,960. After providing for debenture interest and placing £3,000 to credit of renewals fund there remains £16,911 at credit of net revenue account. An interim dividend of 3 per cent. on the "A" preference shares was paid in October last, absorbing £6,000, and the directors now recommend additional dividends on the "A" preference shares of 3 per cent., making 6 per cent. for the year, and on the "B" preference shares of 2½ per cent. These will absorb £9,437, leaving a balance of £1,474 to be carried forward. The arrears of the cumulative dividend on the "B" preference shares amounted on December 31st last to 17 per cent. (17s. per share). Deducting the dividend now recommended the arrears will amount to 14½ per cent. Should the improvement in the traffic receipts experienced since the completion of the electric equipment of the line be continued, as there is reason to expect, the directors hope to be able to further reduce these arrears out of the working of the present year in addition to meeting the full "B" preference dividend for the year. Horse traction was not entirely superseded by the electric traction until September 10th last, so that the disadvantage of the concurrent working of both systems of traction prevailed for the greater part of the year.

The Charing Cross and Strand Electricity Supply Corporation.—The issue of £250,000 4 per cent. debenture stock having previously been very largely over-subscribed, the directors decided to close the subscription lists on Thursday last week—a day earlier than was originally intended. Letters of allotment and regret in connection with the issue have been posted.

TRAFFIC RECEIPTS.

Blackburn Corporation Tramways.—The receipts for the week ending April 12th were £688; corresponding week last year, £496; increase, £192. Total to date, £6,310; corresponding period last year, £5,430; increase, £880. Miles open, 8¼. Partly electrical and steam.

Blackpool and Fleetwood Tramways.—The receipts for the week ending April 13th were £706; corresponding week last year £488; increase, £218. Total to date, £2,973; corresponding period last year, £2,767; increase, £206.

Bristol Tramways and Carriage Company.—The receipts for the week ending April 12th were £5,050 0s. 0d.; corresponding period last year, £3,033 16s. 4d.; increase, £2,016 3s. 8d.

Central London Railway.—The receipts for the week ending April 13th, were £6,652; previous week, £5,654; increase, £998. Total receipts to date (15 weeks), £91,541. Miles open, 6.

City and South London Railway.—The receipts for the week ending April 14th were £1,946; corresponding week last year, £1,159; increase, (Moorgate extension open) £787. Total to date, £30,090; corresponding period last year, £18,478; increase, £11,612. Miles open, 1901, 4½; 1900, 3½.

Dover Corporation Tramways.—The receipts for the week ending April 18th were £252 9s. 11½d.; corresponding week last year, £210 13s. 4d.; increase, £41 16s. 7½d. Total to date, £2,472 2s. 2d.; corresponding period last year, £2,289 18s.; increase, £232 9s. 2d. Miles of track open, 3; Car miles run, 1901, 5,097; 1900, 5,073. Number of cars, 1901, 11; 1900, 11.

Dublin United Tramways Company.—The receipts for the week ending April 12th were as follows:—D. U. T. Co., electric cars, £3,824 11s. 4d.; D. S. D. Co., electric cars, £1,212 12s. 10d.; total £5 037 4s. 2d.; corresponding week last year—D. U. T. Co., electric cars, £3,934 3s. 7d.; ditto, horse cars, £60 16s.; D. S. D. Co., electric cars, £1,167 11s. 2d.; total, £5,162 10s. 9d.; decrease, £125 6s. 7d.; aggregate to date, £56,874 1s. 6d.; aggregate to date last year, £55,723 8s. 6d.; increase, £650 18s. The mileage worked is 45 miles electrically, as against 42 miles electrically, 2 miles by horses, for the corresponding period last year. (Easter week and Spring Show, 1901.) Queen's visit, 1900.

Liverpool Overhead Railway.—The receipts for the week ending April 14th were £1,871; corresponding week last year, £1,351; increase, £520. Total to date, £22,684; corresponding period last year, £20,805; increase, £1,879. Miles open, 6 miles 57 chains.

STOCKS AND SHARES.

Wednesday Evening.

Business in the Stock Exchange has hardly shown that disposition to revive which was expected after the holidays. The gilt-edged markets suffered from anticipation of the Budget, but more in the way of diminishing orders than values. Our lists of electrical and kindred prices exhibit no radical alteration on the week, the only striking feature being the rise in City of London Electric Ordinary shares. The steadiness of the market, however, is a very good feature, and with a decrease in money rates, there must come a gradual appreciation in quotations of the higher class securities.

The electric railway department is attracting renewed interest, Central Londons being the favourite. The price of the Ordinary is better than it would appear from the official quotation, there being buyers at the middle price. A traffic increase of only £2 under the round thousand has helped the market, and it was also strengthened indirectly by the decreases recorded by the two underground rivals. The Metropolitan falling off was £950, and the District £598 for the week. There is renewed talk about the electrification of the latter company's lines, and the stock has been put up a little upon this stale hope, which does not seem to be hurrying towards fulfilment. City and South London stock and shares are unchanged, the traffic increase of £787 being regarded as somewhat disappointing.

At the special settlement in Baker Street and Waterloo Railway shares the making-up prices were fixed as follows:—6½ for the £10 Ordinary shares, fully paid; 2½ for the £6 paid ordinary, 8 for the 4 per cent. fully-paid Preference, and 4 for the Preference £6 paid shares. These quotations are all nominal, and were simply fixed because some price had to be arranged. Somewhat singularly, the new 4 per cent. Debenture stock of the Central London was "specially settled" on the same day, and the making-up price of this is 118, at which the return to a purchaser works out to £3 8s. per cent., a very fair yield considering the excellence of the security.

In the electricity supply section the principal interest of the week has centred round City of London shares, which are up a substantial sum. For this the reason appears to be the change in the company's chairmanship. In the Stock Exchange no other argument can be discovered, and the rise is certainly a delicate compliment to the new chairman. County of London Ordinary and preference are both quoted *ex* dividend, and both show a loss of 10s. in price. The distributions were 4s. and 6s. per share respectively. Some buying of Edmundson's has led to a rise of ¼. The new Charing Cross and Strand Debenture is quoted at 2 to 4 premium, and it is understood that the issue met with remarkable success, as it certainly deserved to do. In all probability the investment will climb up a few points within the next six months, and old ladies holding Charing Cross Debenture need fear no sleepless nights from the character of their security.

Turning to telegraphs, the firmness of Anglo-American 6 per cent. Preferred is the outstanding feature. After deduction of the 30s. per cent. dividend, the price shows a loss of one point, and there are buyers in the land. As a speculative investment the stock has for the last two years been suggested to our readers as worth having. The boom in American rails, although it shows signs of slackening now, must have benefitted the company's coffers considerably during the past half year. In the Eastern division, an excellent "China" report has made its appearance. An increase of receipts wedded to a decrease in expenses, makes a capital showing, and the company is now in a very strong position. Moreover, a reduction in rates was made on New Year's Day, and that this can be worked profitably, is the best answer that could be given to those who dread the "All-British" competition. The Indo-European Telegraph Company, despite the rate-reduction, also did well in 1900, but the receipts include a sum of £17,200 from the Persian Government. No date is mentioned by the report as to when the interminable pourparlers with the German Government are likely to come to an end, but we suppose that it can be only a question of time before the company gets its concession for extension of its lines. The price is a point lower on the week. Submarine Cables Trust Certificates are marked down three points; this is, of course, merely equivalent to the dividend. Great Northerns are up £1 on good buying induced by the increased dividend.

National Telephone Debenture stocks are both 1 per cent. lower. Telephone descriptions will soon be worth picking up, but from the look of the market a further decline in its premier stocks is not improbable. Orientals are unchanged on the dividend just declared.

British Electric Traction shares of both classes are up 10s., and those who can make a profit by selling might fairly do so in the hope of repurchasing more cheaply later on. The Buenos Ayres and Belgrano Electric Tram Company's receipts continue to expand. It sounded like a repetition of recent history when the chairman of the Central Argentine Railway complained the other day that these electric trams were proving formidable competitors to his company.

In the manufacturing division the two heavier companies' shares have justified their designation, and are inclined to dulness. Brush shares are better, having recovered the dividend of 2s. on the Ordinary and 1s. 2⅞d. on the Preference. Babcock & Wilcox remain at 3 *ex* dividend; the meeting, which told of exceptionally hard work during the year, had no effect upon the price. Willans and Robinson Ordinary have been dealt in to-day, Wednesday, at 11⅜, and the Preference are 6⅞. A scheme is on foot for raising £100,000 in second Debenture stock by the Thames Iron Works Company, and there are reports afloat of amalgamation between this and several other kindred undertakings.

SHARE LIST OF ELECTRICAL COMPANIES.—TELEGRAPH AND TELEPHONE COMPANIES.

Present Issue.	NAME.	Stock or Share. ‡	Dividends for the last three years. 1898.	1899.	1900.	Closing Quotations April 10th.	Closing Quotation April 17th.	Business done during week ended April 17th, 1901. Highest	Lowest
96,900	African Direct Telegraph, 4 % Debs.	100	...	...	...	99 —102	99 —102	...	...
119,700	Amazon Telegraph 5 % Debs., Nos. 1 to 1,250 Red. ...	100	...	...	...	55 — 65	55 — 65	...	...
822,700	Anglo-American Telegraph	Stock	£3 9s.	73/6	3½%	51 — 54	50 — 53 xd	...	...
3,088,540	Do. do. 6 % Pref.	Stock	6 %	6 %	6 %	95 — 97	94 — 96 xd	95⅝	95
3,088,540	Do. do. Deferred	Stock	18s. %	£1 7s.	5s.%	8¼— 8¾	8¼— 8¾	8½	...
44,000	Chili Telephone, Nos. 1 to 44,000	5	3 %	4 %	...	3 — 3⅛	3 — 3⅛	3⅜	...
13,333,300$	Commercial Cable	$100	8 %	8 %	...	160 —170	160 —170	...	...
1,589,496£	Do. do. Sterling 500 year 4 % Deb. Stock Red.	Stock	...	...	...	101 —103	100 —102	102½	101
16,000	Cuba Telegraph	10	8 %	7 %	...	7½— 8½	7½— 8½	...	...
6,000	Do. 10 % Pref.	10	10 %	...	...	16 — 17	16 — 17	...	...
12,931	Direct Spanish Telegraph	5	4 %	4 %	4 %	3 — 4	3 — 4	3⅛	...
6,000	Do. do. 10 % Cum. Pref.	5	...	...	...	9 — 10	9 — 10	...	...
30,000	Do. do. 4½ % Debs.	50	...	...	...	100 — 104%	100 —104%	...	...
60,710£	Direct United States Cable	20	3½%	3 %	3 %	9¾— 10¼	9¾— 10¼	10 1/16	...
108,300	Direct West India Cable, 4½ % Reg. Deb.	100	...	...	...	99 —102	99 —102	...	...
4,000,000	Eastern Telegraph, Ord. Stock	Stock	7 %	7 %	...	143 —148	140 —145 xd	142¾	141
1,826,888	Do. 3½ % Pref. Stock	100	...	...	...	92 — 95	91 — 94 xd	...	...
1,432,268£	Do. 4 % Mort. Deb. Stock Red.	Stock	...	...	...	113 —117	113 —117	115½	113
250,000	Eastern Extension, Australasia, and China Telegraph ...	10	7 %	7 %	7 %	14¼— 14⅜	14¼— 14⅜	14⅜	14¼
50,000	Do. Nos. 250,001 to 300,000 (iss. at £3 pm. all pd.) ...	10	...	...	...	13⅜— 14¼	13⅜— 14¼	13 15/16	13⅜
320,000£	Do. 4 % Deb. Stock	Stock	...	...	...	111 —116	111 —116	...	...
300,000£	Eastern and South African Telegraph, 4 % Mort. Deb. Nos. 1 to 3,000, red. 1909	100	...	...	...	99 —102	99 —102	...	...
200,000£	Do. 4 % Reg. Mt. Debs. (Mauritius Sub.) 1—8,000	25	...	...	...	101 —104%	101 —104%	...	..
180,227	Globe Telegraph and Trust	10	5⅛%	5⅛%	...	9⅜— 10¼	9⅜— 10¼	10¼	9⅞
180,042	Do. do. 6 % Pref.	10	6 %	...	...	14⅜— 15½	14⅜— 15½	15⅛	14⅜
150,000	Great Northern Telegraph, of Copenhagen	10	12½%	...	15 %	32 — 34	33 — 35	...	...
82,000	Halifax and Bermuda Cable, 4½ % 1st Mort. Debs., within Nos. 1 to 1,200, Red.	100	...	...	...	99 —102	99 —102	...	...
17,000	Indo-European Telegraph	25	10 %	10 %	10 %	46 — 50	45 — 49	46	...
100,000£	London Platino-Brasilian Telegraph, 6 % Debs.	100	...	...	...	103 —106	103 —106	...	...
72,680	Montevideo Telephone, Limited, Ord., Nos. 1 to 72,680 ...	1	...	2½%	...	¼— ½	¼— ½	...	...
86,492	Do. do. do. 5 % Pref., Nos. 1 to 86,492	1	4 %	5 %	...	¾— 1	¾— 1	...	...
590,000	National Telephone, 1 to 590,000	5	6 %	5 %	5 %	3⅛— 3⅜	3 — 3¼	3 3/16	...
15,000	Do. 6 % Cum. 1st Pref.	10	6 %	6 %	6 %	11 — 13	11 — 13	...	...
15,000	Do. 6 % Cum. 2nd Pref.	10	6 %	6 %	6 %	10 — 12	10 — 12	...	...
250,000	Do. 5 % Non-cum. 3rd Pref., 1 to 250,000	5	5 %	5 %	5 %	4¼— 4½	4¼— 4½	...	...
2,000,000£	Do. 3½ % Deb. Stock Red.	Stock	3½%	3½%	3½%	90 — 93	89 — 92	...	...
500,000	Do. 4 % Deb. Stock Red.	100	...	...	4 %	96 — 99	95 — 98	98	...
171,504	Oriental Telephone and Elec., Nos. 1 to 171,504, fully paid	1	5 %	5 %	6 %	⅞— 1⅛	⅞— 1⅛	...	...
100,000£	Pacific and European Tel., 4 % Guar. Debs., 1 to 1,000 ...	100	...	...	...	99 —102	99 —102	...	...
11,839	Reuter's	8	5 %	5 %	...	7½— 8½	7½— 8½	7½	...
3,381	Submarine Cables Trust	Cert.	...	...	...	124 —129	121 —126 xd	...	...
58,000	United River Plate Telephone	5	6 %	7 %	...	4½— 5	4½— 5	...	...
40,000	Do. do. 5 % Cum. pref. Nos. 1—40,000	5	...	...	...	4⅝— 5¼	4⅝— 5¼	...	...
179,947	Do. do. 5 % Debs.	Stock	...	...	...	103 —106	103 —106	103⅜	...
171,000	West African Telegraph, 5 % Debs....	100	...	...	...	97 —100	97 —100	...	...
30,008	West Coast of America, Nos. 1—30,000 and 53,001—53,008	2½	...	...	...	¼— ⅜	¼— ⅜	...	...
150,000	Do. do. 4 % Debs., 1—1,500 gua. by Braz. Sub. Tel.	100	...	...	...	99 —102	99 —102	..	...
207,930	Western Telegraph, Ltd., Nos. 1—207,930	10	7 %	7 %	...	13⅜— 14¼	13⅜—14¼	14⅛	13⅞
75,000	Do do. 5 % Debs. 2nd series, 1906 ...	100	...	...	...	101 —104	101 —104	...	...
348,777	Do. do. 4 % Deb. Stock Red.	100	...	...	...	102 —105	102 —105	...	...
88,321	West India and Panama Telegraph	10	2 %	⅝%	...	⅝— ¾	⅝— ¾	...	...
34,563	Do. do. do. 6 % Cum. 1st Pref. ...	10	...	...	...	6 — 7	6 — 7	6⅝	6 7/16
4,669	Do. do. do. 6 % Cum. 2nd Pref. ...	10	...	...	...	5 — 7	5 — 7	...	..
80,000£	Do. do. do. 5 % Debs., Nos. 1 to 1,800	100	...	...	...	103 —106	103 —106	...	...

ELECTRICITY SUPPLY COMPANIES.

19,661	Brompton & Kensington Elec. Lt. Sup., Ord., 101 to 19,761	5	6 %	6 %	6 %	7⅝— 8¼	7⅝— 8¼	...	...
12,000	Do. do. 7 % Cum. Pref....	5	...	...	...	8¼— 8⅜	8¼— 8⅜	8⅜	...
50,000	Charing Cross and Strand Electricity Supply	5	8 %	9 %	9 %	9 — 10	9 — 10	9¼	
20,000	Do. do. do. do. 4½% Cum. Pref.	5	...	...	...	5 — 5½	5 — 5½	5½	5⅛
34,000	*Chelsea Electricity Supply, Ord.	5	6 %	6 %	5½%	5⅝— 6¼	5⅝— 6¼	..	...
150,000	Do. do. do. % Deb. Stock Red. ...	Stock	...	...	...	109 —112	109 —112	...	...
70,579	City of London Electric Lighting, Ord. 40,001—110,579...	10	6 %	4 %	...	7 — 8	8½ — 9½	9¼	8 1/16
40,000	Do. 6 % Cum. Pref., 1 to 40,000	10	6 %	...	...	12 — 13	12 — 13	...	...
400,000	Do. 5 % Deb. Stock, Scrip. (iss. at £115) all paid	...	...	...	...	121 —126	121 —126	...	...
40,000	County of Lond. & Brush Prov. Elec. Ltg., Ord. 1—40,000	10	*nil*	4 %	4 %	8½— 9½	8 — 9 xd	...	...
20,000	Do. do. do. 6 % Pref., 40,001—60,000	10	6 %	...	...	11½— 12½	11 — 12 xd	11⅜	...
200,000	Do. 4½ % Deb. Stock, Prov. Certs (all paid) Rd. ...	...	...	...	...	106 —109	106 —109	...	...
35,500	Edmundson's Elec. Corp., Ord. Shares	5	7 %	...	...	4⅜— 5¼	5 — 5½	..	...
75,000	Do. do. 4½ % 1st Mort. Deb. Stock. ...	100	...	...	...	103 —106	103 —106	105½	...
21,000	Kensington and Knightsbridge Electric, Ord.	5	...	...	...	... — ...	10½— 11½	...	...
90,000	Do. do. do. 4 % Deb. Stock	Stock	...	...	...	... — ...	101 —104	...	...
110,000	London Electric Supply Corporation, Limited, Ord. ...	3	...	...	...	1½— 1⅝	1½— 1⅝	...	...
49,840	Do. do, do. do. 6 % Pref.	5	6 %	...	...	3½— 4½	3½— 4½	4	...
250,000	Do. do. do. 4% 1st Mt. Db. Stock Rd.	Stock	...	...	...	98 —101	98 —101	..	
85,000	Metropolitan Electric Supply, 101 to 62,500	10	5 %	5 %	6 %	11½— 12½	11½— 12½	12⅝	11⅜
220,000£	Do. 4½% First Mortgage Debenture Stock	...	...	...	...	110 —113	110 —113	...	...
250,000	Do. 3½% Mort. Deb. Stock Red.	Stock	...	...	...	97 —100	97 —100	...	...
6,452	Notting Hill Electric Lighting	10	6 %	7 %	7 %	15½— 16½	15¼— 16½	...	
40,000	St. James's and Pall Mall Electric Light, Ord.	5	14½%	14½%	14½%	13½— 14½	13½— 14½	14 1/16	14⅛
20,000	Do. do. 7 % Pref., 20,081 to 40,080	5	7 %	7 %	7 %	8½— 9½	8½— 9½	...	...
150,000	Do. do. 3½ % Deb. Stock Red. ...	100	...	...	...	98 —101	98 —101	...	..
12,000	Smithfield Market Elect. Supply, Ord.	5	...	...	...	2 — 2½	2 — 2½	..	...
50,000	Do. do. 4 % Deb.	100	...	...	...	80 — 90	80 — 90	...	...
65,000	South London Electricity Supply, Ord.	5	...	...	...	2½— 3½	2½— 3½	...	..
79,900	Westminster Electric Supply, Ord., 101 to 80,000... ...	5	12 %	13 %	10½%	11½— 12½	11½— 12⅝	12¼	11 5/8

* Subject to Founders Shares. Quotations on Liverpool Stock Exchange.
Unless otherwise stated all shares are fully paid. ‖ Dividends paid in deferred share warrants, profits being used as capital
Dividends marked ‡ are for a year consisting of the latter part of one year and the first part of the next.

SHARE LIST OF ELECTRICAL COMPANIES.—*Continued.*

ELECTRICAL RAILWAY, MANUFACTURING, AND INDUSTRIAL COMPANIES.

Present Issue.	NAME.	Stock or Share.	Dividends for the last three years. 1898.	1899.	1900.	Closing Quotation April 10th.	Closing Quotation April 17th.	Business done week ended April 17th, 1901. Highest	Lowest
		†							
20,000	British Aluminium 7 % Cum. Pref.	10	...	...	...	7½ — 8½	7½ — 8½	...	...
300,000	Do. do. 5 % 1st Mort. Deb. Stock Red. ...	Stock	...	...	...	91 — 95	91 — 95	...	...
45,000	British Electric Traction	10	6 %	...	...	15 — 16	15½ — 16	15⅝	15½
50,000	Do. do. 6 % Cum. Pref.	10	...	...	...	11½ — 12½	12 — 13	12 9/16	12 3/16
350,000	Do. do. 5 % Perpetual Debenture Stock ...	Stock	...	...	...	119 —122	119 —122	120½	120¼
85,000*l*	†British Electric Works Co., Ord. £1 shares, 50,001—135,000	...	...	...	...	1/16 — 3/16	1/16 — 3/16	...	...
50,000	† Do do. 6 % Cum.Pref., 1—50,000 ...	...	...	...	...	3/16 — 5/16	3/16 — 5/16	...	...
500	† Do. do. 4½ % 1st Mort. Deb.	100	...	...	...	85 — 90	85 — 90	...	...
70,000	British Insulated Wire Ord.	5	15 %	20 %	15 %	10 — 11	10 — 11	...	...
70,000	Do. do. 6 % Cum. Pref.	5	...	...	...	5⅜ — 6¼	5⅜ — 6¼	...	...
90,000	Brush Elecl. Enging., Ord., 1 to 90,000	2	5 %	6 %	...	1⅜ — 1⅝	1⅜ — 1⅝xd	1⅜	1⅜
90,000	Do. do. Non-cum. 6 % Pref., 1 to 90,000 ...	2	6 %	6 %	...	2 — 2¼	2 — 2¼xd	2¼	2 1/16
125,000*l*	Do. do. 4½ % Perp. Deb. Stock	Stock	...	...	...	103 —108	103 —108	...	...
108,710	Do. do. 4½ % Perp. 2nd Deb. Stock ...	Stock	...	...	...	101 —103	101 —103	...	...
30,000	Callender's Cable Construction shares, Nos. 1—30,000 ...	5	15 %	15 %	...	15 — 16	15 — 16	...	...
40,000	Do. do. 5 % Cum. Pref.	5	...	...	...	5½ — 6	5½ — 6	5 1/16	...
90,000	Do. do. 4½ % 1st Mort. Deb. Stock Red ...	Stock	...	...	...	109 —113	109 —113	...	...
206,297	Central London Railway, Ord. Shares	10	...	...	...	9 — 9⅛	9 — 9⅛	9⅛	9¼
78,703	Do. do. Pref. half-shares	5	...	...	...	4⅞ — 5¼	4⅞ — 5¼	...	...
78,703	Do. do. Def. do.	5	...	...	...	4 — 4½	4¼ — 4⅝	...	...
855,000	City and South London Railway	Stock	2⅛%	1⅞%	1¼%	46 — 50	46 — 50	...	...
37,500	Do. do. Ord. shares Nos. 22,501 to 60,000	10	...	...	...	4 — 5	4 — 5	...	...
54,000	Crompton & Co., Nos. 1 to 54,000	3	6 %	7½%	...	3½ — 4	3½ — 4	...	...
100,000	Do. 5 % 1st Mort. Reg. Debs., 1 to 900 of £100, and 901 to 11,000 of £50 red	...	...	...	...	100 —103	100 —103	...	...
99,261	Edison & Swan Utd. El. Lgt., "A" shares, £3 pd. 1 to 99,261	5	6 %	6 %	...	1½ — 2	1½ — 2	...	...
17,139	Do. do. do. "A" Shares, 01—017,139 ...	5	6 %	6 %	...	3 — 4	3 — 4	...	...
344,023	Do. do. do. 4 % Deb. Stock Red ...	100	...	...	...	87 — 89	87 — 89	...	...
100,000	Do. do. 5% 2nd Deb. Stock Prov. Certs. all pd.	100	...	...	...	94 — 98	94 — 98	...	...
112,100	Electric Construction, 1 to 112,100	2	6 %	6 %	...	1⅜ — 2¼	1⅜ — 2¼	...	...
25,000	Do. do. 7 % Cum. Pref., 1 to 25,000... ...	2	7 %	...	...	2½ — 3	2½ — 3	...	...
182,500	Do. do. 4 % Perp. 1st Mort. Deb. Stock ...	Stock	...	...	...	101 —104	101 —104	...	...
9,600*l*	Greenwood & Batley, 7 % Cum. Pref., 1 to 9,600 ...	10	7 %	7 %	...	10 — 11	10 — 11	...	...
35,000	Henley's (W. T.) Telegraph Works, Ord.	5	14 %	15 %	20 %	15 — 16	15 — 16	15⅜	15½
35,000	Do. do. do. 4½ % Pref.	5	7 %	...	...	5½ — 6	5½ — 6	5⅝	...
50,000	Do. do. do. 4½ Mort. Deb. Stock...	Stock	...	...	...	107 —111	107 —111	...	...
50,000	India-Rubber, Gutta-Percha and Telegraph Works ...	10	10 %	10 %	...	21 — 22	21 — 22	21	...
300,000	Do. do. do. 4 % 1st Mort. Deb	100	...	...	...	101 —104	101 —104	...	...
37,500	†Liverpool Overhead Railway, Ord.	10	3½%	3⅜%	3¼%	7⅜ — 7⅞	7⅞ — 8	...	...
10,000	† Do. do. Pref., £10 paid	10	5 %	5	...	13 — 13½	13 — 13½	...	...
37,350	Telegraph Construction and Maintenance	12	15 %	15 %	17½%	37 — 41	36 — 40	38¼	36
150,000	Do. 4 % Deb. Bds. Nos. 1 to 1,500 Red. 1909 ...	100	...	...	...	101 —104	101 —104	...	...
20,000	Telegraph Manufacturing, Ord. Nos. 1 to 20,000	5	8 %	12 %	...	11 — 12	11 — 12	...	...
20,000	Do. do. 5 % Cm. Prf. Nos. 1 to 20,000...	5	...	...	...	5½ — 6	5½ — 6	5⅝	...
540,000*l*	Waterloo and City Railway, Ord. Stock	100	3 %	3 %	3 %	94 — 97	94 — 97	...	...

† Quotations on Liverpool Stock Exchange.

‡ Unless otherwise stated all shares are fully paid.

LATEST PROCURABLE QUOTATIONS OF SECURITIES NOT OFFICIALLY QUOTED.

Consolidated Telephone Construction and Maintenance, 3/—4/-
National Electric Free Wiring, 12/6 paid, 7/6—1/-.
Oldham, Ashton, and Hyde Electric (£10 pd.), Ord., 16—17.
Do. do. Pref. (£10 pd.), 10—11.
*T. Parker, £10 (fully paid), 16½.

* From Birmingham Share List.

Bank rate of discount 4 per cent. (February 21st, 1901).

MARKET QUOTATIONS, Wednesday, April 17th.

CHEMICALS, &c.		This week.	Last week.	Inc. or Dec.
a Acid, Hydrochloric	per cwt.	5/-	5/-	..
a ,, Nitric	per cwt.	22/-	22/-	..
a ,, Oxalic	per cwt.	32/-	32/-	..
a ,, Sulphuric	per cwt.	5/6	5/6	..
a Ammoniac, Sal	per cwt.	89/-	89/-	..
a Ammonia, Muriate (crystal) ..	per ton	£33 10	£33 10	..
a ,, ,, ..	per ton	£30	£30	..
a Bleaching powder	per ton	£7	£7	..
a Bisulphide of Carbon	per ton	£15	£15	..
a Borax	per ton	£17 10	£17 10	..
a Bensole (90 %)	per gal.	7/-	7/-	..
a ,, (50/90%)	per gal.	5/6	5/6	..
a Copper Sulphate	per ton	£25	£25	..
a Lead, Nitrate	per ton	£25	£25	..
a ,, White Sugar	per ton	£31	£31	..
a ,, Peroxide	per ton	£27 10	£27 10	..
a Methylated Spirit	per gal.	2/6	2/6	..
a Naphtha, Solvent (90% at 160° C).	per gal.	5/6	5/6	..
a Potash, Bichromate, in casks..	per lb.	3¼d.	3¼d.	..
a ,, Caustic (75/80%) ..	per ton	£24	£24	..
a ,, Bisulphate	per ton	£35	£35	..
a Shellac	per cwt.	64/-	64/-	..
a Sulphate of Magnesia	per ton	£4 10	£4 10	..
a Sulphur, Sublimed Flowers ..	per ton	£6 5s.	£6	..
a ,, Recovered	per ton	£5 10	£5 10	..
a ,, Lump	per ton	£5	£5	..
a Soda, Caustic (white 70 %) ..	per ton	£10 15	£10 15	..
a ,, Crystals	per ton	£3	£3	..
,, Bichromate, casks ..	per lb.	2½d.	2¾d.	..

METALS, &c.				
b Aluminium Wire, in ton lots..	per ton	£224	£224	..
b ,, Sheet, in ton lots	per ton	£191	£191	..
p Babbitt's metal ingots.. ..	per ton	£75 to £130	£75 to £130	..
c Brass (rolled metal 2" to 12") basis	per lb.	7½d.	7½d.	..
c ,, Tube (brazed)	per lb.	10d.	10d.	..
c ,, ,, (solid drawn) ..	per lb.	8½d.	8½d.	..
c ,, Wire, basis	per lb.	8d.	8d.	..
c Copper Tubes (brazed) ..	per lb.	11d.	11d.	..
c ,, ,, (solid drawn) ..	per lb.	10½d.	10½d.	..
g Copper Bars (best selected) ..	per ton	£84	£84	..

METALS, &c. *(continued.)*		This week.	Last week.	Inc. or Dec.
g Copper Sheet	per ton	£84	£84	..
g ,, Rod	per ton	£84	£84	..
c ,, (Electrolytic) Bars ..	per ton	£82	£82	..
c ,, ,, Sheets ..	per ton	£90	£90	..
c ,, ,, Rod ..	per ton	£84	£84	..
c ,, ,, H.C. Wire	per lb.	9¾d.	9¾d.	..
f Ebonite Rod	per lb.	3/-	3/-	..
f ,, Sheet	per lb.	5/-	5/-	..
n German Silver Wire	per lb.	1/5	1/6	1d. dec.
h Gutta-percha fine	per lb.	8/-	8/-	..
h India-rubber, Para fine	per lb.	3/10½	3/9	1½d. inc.
i Iron, Charcoal Sheets	per ton	£18	£18	..
i ,, Pig (Cleveland warrants) ..	per ton	45/4	45/-	4d. inc.
i ,, Forgings, according to size	per ton	From £11	From £11	..
i ,, Scrap, heavy	per ton	70/- to 72/6	70/- to 72/6	..
i ,, Wire, galvanised No. 8 ..	per ton	£10	£10	..
g Lead, English Ingot	per ton	£12 10 to £12 15	£13	10s. dec
g ,, ,, Sheet	per ton	£15	£15	..
m Manganin Wire No. 28	per lb.	8/-	8/-	..
g Mercury	per bot.	£9 2 6	£9 2 6	..
d Mica (in original cases), small ..	per lb.	8d. to 9d.	8d. to 9d.	..
d ,, ,, ,, medium	per lb.	1/9 to 2/9	1/9 to 2/9	..
d ,, ,, ,, large ..	per lb.	3/3 to 7/3	3/3 to 7/3	..
p Phosphor Bronze, plain castings	per lb.	1/0½ to 1/3	1/0½ to 1/3	..
p ,, rolled bars & rods	per lb.	1/1 to 1/4	1/1 to 1/4	..
p ,, ,, strip & sheet	per lb.	From 1/3	From 1/3	..
o Platinum	per oz.	£4	£4	..
p Silicium Bronze Wire	per lb.	10½d. to 1/0½	10½d. to 1/0½	..
i Steel, Magnet, acc'd'ng to desc'p'n	per ton	From £15	to £40	..
i ,, ,, in bars		£58	£58	..
g Tin, block	per ton	£120 10 to £121 10	£119 to £120	30s. inc.
g ,, foil	per lb.	1/9	1/9	..
n ,, wire, Nos. 1 to 16	per lb.	1/8	1/9	1d. dec.
p White Anti-friction Metals — "White Ant" brand	per ton	£40 to £70	£35 to £65	dec.
j Yarns, Cotton, Single 10 lb. b'ndl's	per lb.	9d.	9d.	..
j ,, Best Flax, 6 lea.	per lb.	6d.	6d.	..
j ,, Hemp, 3 ply 10 lbs. ..	per lb.	4½d.	4½d.	..
j ,, ,, Russian, 10 lbs. ..	per lb.	5½d.	5½d.	..
j ,, Jute, 180 lbs. rove ..	per ton	£14	£14	..
k Zinc, Sh's. (Vielle Montagne and.)	per ton	£21	£21	..

Quotations supplied by { *a* Messrs. G. Boor & Co. *b* The British Aluminium Co., Ltd. *c* Messrs. Thos. Bolton & Sons. *d* Messrs. F. Wiggins & Sons. *e* Messrs. Frederick Smith & Co.

Quotations supplied by { *f* India-Rubber, G.-P. and Teleg. Works *g* Messrs. James & Shakspeare. [Co., Ltd. *h* Messrs. Jackson & Till. *i* Messrs. Bolling & Lowe. *j* Messrs. Henry C. Yeo & Co.

Quotations supplied by { *k* Messrs. Morris Ashby, Limited *m* Messrs. W. T. Glover & Co., Ltd. *n* Messrs. P. Ormiston & Sons. *o* Messrs. Johnson, Matthey & Co., Ltd. *p* The Phosphor Bronze Company, Ltd.

INSTITUTION OF ELECTRICAL ENGINEERS.

SOME NOTES ON POLYPHASE SUB-STATION MACHINERY.

By A. C. Eborall, Member.

(Abstract of paper read on Thursday, March 14th, 1901.)

(*Continued from page* 623.)

Should a momentary short-circuit pull out the circuit-breakers in the power station, it is always necessary to give the sub-stations time to shut down, rather than immediately replace the circuit-breakers, while the converting machines are still turning.

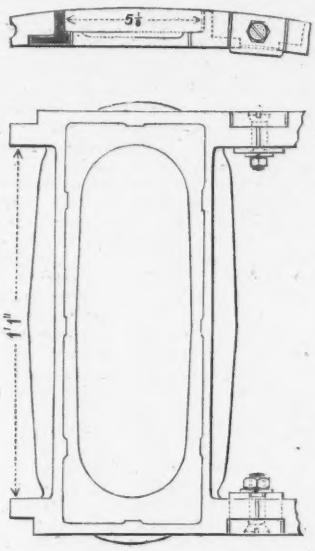
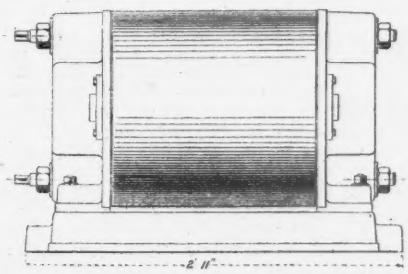


Fig. 7.—Combined Damping Coil and Field Coil Support for 725-b.h.p. Synchronous Motor.

Speed, 212 revolutiens per minute; frequency, 50 cycles; peripheral speed, 5,500 ft. per minute.

One of the most important questions to be considered in connection with the design and operation of a synchronous sub-station equipment is that of parallel running. The converting machines have not only to run perfectly in parallel with one another, but the various sub-stations have to run perfectly in parallel with one another, and with the power station also.



With a rotary converter sub-station, for instance, unless every detail of the system is thoroughly well designed, from the engines in the power station to the rotaries themselves, there will be trouble with regard to the parallel running of the machines—that is to say, they will hunt. The term hunting, as applied to synchronous machinery of this character, means that while running at synchronous speed (as measured by a tachometer), the machines oscillate between themselves—that is, during a revolution they increase and decrease their angular velocity above the mean velocity, corresponding to exact synchronism, causing the armatures to swing backwards and forwards from a fixed point (in a precisely similar manner to the swing of a pendulum) while still keeping in step. The effect of this is to cause the pressure on each side of the rotary to fluctuate more or less badly, so that working at constant pressure on the direct current sides becomes impossible. Once a rotary has started hunting, unless the small oscillations are immediately checked, they will invariably continue to increase in amplitude until the armature swings over and loses synchronism.

The running performance of synchronous (motor) machinery depends so much upon the variations in the velocity of the power house engines during a revolution, and upon the oscillations set up by the engine governors, &c., that if these variations or oscillations exceed certain well-defined limits it becomes impossible to operate the sub-stations successfully.

But although hunting may be sometimes caused in this way, the speed variations in the engines are by no means a necessary accompaniment to it, for it may be started in a variety of ways (of which engine pulsation is one), and then increased by the action of the machines themselves.

A working explanation of what happens in this case is as follows:—Let a slight oscillation be set up between the machines, by any little thing that may occur with the most perfectly designed plant it is possible to have, such as a sudden large change in the load, a short circuit, or faulty setting of the brushes on one machine, or an engine hunting in the power station (due to a small mishap, &c.). This slight oscillation is accompanied by a weakening and distortion of the field flux of the converter. The mere fact of there being an oscillation implies field distortion, for a fixed point on the armature during the swing is either a little ahead of or a little behind the true position (corresponding to exact synchronism) it should have at this instant. This means that the machine is acting either as a generator or motor, taking either a leading or a lagging current from the lines, and shifting the diminished field flux to one or other of the pole horns. The armature will now try to follow this change of field configuration, taking a large current in the reverse direction in order to do so. But this change of current immediately distorts the field flux in the opposite direction to a much larger extent, and the armature again tries to swing to the new position. Thus each oscillation of the armature gets larger and larger, and the field distortion is greater and greater, until finally the flux from the poles gets swept nearly entirely away from the pole faces to the pole horns and gaps between them, the machine eventually swinging out of synchronism. During these oscillations the converter is acting alternately as generator or motor, giving up to, or receiving power from, the other converters in parallel with it, giving them in this way alternately a push and a pull at the wrong times, causing them to start hunting also. The combined effect of the various machines in parallel is to increase the hunting originally set up, and if other sub-stations are in parallel the oscillations may also be taken up by the machines in these, the combined effect perhaps even reacting on the generators in the power station, causing them to start oscillating also. It is thus obviously necessary to provide means of checking the oscillations while they are still small, otherwise they will get out of control and spread over the whole system.

The sparking and flashing over which frequently takes place at the commutators of rotary converters when hunting, is directly due to the pulsation of energy, and to the field distortion and fluctuation, for good commutation under these conditions naturally becomes impossible. The distortion of the field is really the root of the whole matter, and if this is prevented, or reduced to a minimum, hunting cannot occur.

There are certain conditions of working which tend to cause hunting, or which make hunting worse should it be set up. An example of the former is difference in the form of the E.M.F. waves

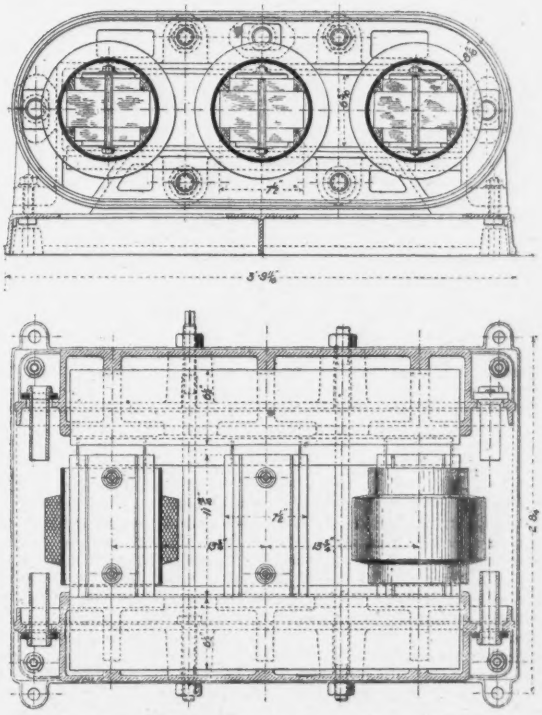


Fig. 8.—Three-Phase Choking Coil. 25 kw., 50 Cycles.

of generators and rotaries. On the other hand, machines with strong armature reaction, or working much under excited, are more liable to hunt than those with strong fields, because the magnetic flux is more readily distorted. For this latter reason it follows that over-excitation of the rotaries is a condition favourable to good operation. Again, the momentum of the converters should be kept as low as possible, for this apparently indirectly assists hunting, and in any case impairs the action of any device that may be used for damping the oscillations in their early stages. The author

considers that a moderate amount of self-induction in the lines is directly beneficial. Capacity in the feeders appears to have some influence. In practice, however, it is generally difficult to separate the causes that assist hunting from one another. The main cause will generally be found to lie with the engines.

Synchronous motor-generators are far less likely to hunt (with a given generating plant and transmission system) than rotary converters. This is because there is considerable armature reaction in the synchronous motors, which tends to damp the pulsations in the armature current should hunting be set up, and also because the field system is fed at a steady pressure, which is totally independent of the pressure at the ends of the feeders. But with unsuitable engines synchronous motors will hunt badly, the pressure on the direct current side being practically unaffected thereby, which is a point to be noted.

It will be seen that to ensure the perfectly satisfactory operation of synchronous sub-station machinery, two points must be attended to. The first is to take great care with the selection and operation of the generating and sub-station plant, particularly the former, so that the tendency to set up hunting will be as small as possible; and the second is to provide means for getting rid of the hunting—that is, damp the armature oscillations in their earlier stages—should it be set up.

The oscillations are accompanied by, and intimately connected with, the field distortion as described above; happily, for suppressing the distortion of the field flux, all that has to be done is to fit the synchronous motors or rotary converters with "damping coils." This device, which rarely fails to stop the worst cases of hunting, is to bridge the poles from horn to horn by copper plates or strips. These damp the armature oscillations by reason of the eddy currents produced in them by the flux due to the large leading and lagging armature currents—that is to say, as soon as the armature starts swinging, accompanied by the field distortion described above, the opposing flux produced by the eddy currents in the copper strips blows it away from between the pole-horns, and the oscillations are thus damped out magnetically directly they commence to form. It will be observed that the damping coils produce their effect just where it is wanted, namely, between the pole-horns. It is relatively of little use to put damping coils *round* the pole-pieces.

The dimensions of the copper strips can be varied within wide limits without making much difference to the damping action. The losses in them with actual rotary converters are found to vary from 0·5 to 1·5 per cent. of the output of the machine, depending upon circumstances. An idea of the actual dimensions of damping coils used in practice is given by fig. 7, which illustrates the bronze damping coils, combined with the outside cheeks of the field bobbins, for the synchronous motor of the 500-KW. two-phase motor-generator already illustrated. The damping strips bridging the pole-horns of the rotating magnet wheel are cut away centrally, partly because the centre portion is not very effective, but principally in order to prevent the ventilation of the magnet wheel and armature being impaired.

As rotary converters will hunt upon slight provocation, such machines should always be fitted with damping coils, whatever the nature of the engines. They need only be used with synchronous motor-generators when the power station engines are badly designed, unless lighting is done from the same feeders. In this case it will generally pay to use them. On the other hand, if the engines are very bad they should be used on the generator field-poles as well, where they will have a precisely similar effect (for the case is similar), and will reduce the synchronising current between the generators practically to zero.

One result of hunting in the sub-stations is that the current in the high pressure feeders pulsates. These pulsations occur to a certain extent even when hunting is absent, for they are due to the inherent properties of the machines. This pulsation of current in the feeders, accompanied as it is by corresponding pulsations in the pressure, becomes highly inconvenient if lighting has to be done directly from the feeders in question. The remedy, first put actually into practice by Mr. Kolben in connection with the electricity supply for the town of Prague, is to insert choking coils in the high pressure sub-station feeders, these being of the three-phase type with common core for three-phase working. The output of the choking coil in circuit with each feeder should be about 3 per cent. of the maximum power absorbed by the synchronous machinery connected to it. Thus in Prague, for instance, in one case a 900-KW. sub-station is connected by a three-core cable to the power house 3¼ miles away, a three-phase choking coil of 25 KW., having an air-gap adjustable (by packing pieces) to about 0·375 in., being in series with it. The principal dimensions of this coil are given in fig. 8. The fluctuation in the pressure at the sub-station end of the feeder when working under the worst conditions (no load) is about 3 per cent. with the coils cut out, and nothing that can be detected when they are in circuit. When the coils are in use, the synchronising current between the two synchronous motors of 650 B.H.P. is 8 to 10 amperes with an input of 60 amperes, and 5 to 10 amperes at full load (100 amperes), but when they are cut out the motor synchronising currents are more than double.

The use of choking coils in the sub-station feeders has proved to be of the greatest value in Prague, because all the lighting and motor work is done from the same three-phase mains, the direct current sub-stations serving only for the tramways. The pressure variation at the sub-station only varies between 2,900 and 2,980 volts, and does not change with the load, because the synchronising currents of the motors do not alter appreciably with the load; the excitations of the motors are hardly altered, being 62 amperes at no load, and 65—70 amperes at full load, the latter figure being attained when heavy momentary overloads are expected.

The use of choking coils may be thought objectionable, on account of the increased losses and pressure drop, but this disadvantage is but trifling, and far more than counterbalanced by the advantage of doing away with all pulsations in the pressure. The full load loss in a large choking coil is not more than about 3 per cent., and the inductive drop under usual working conditions, say 4 per cent. With the above-mentioned 25-KW. choking coils, the full-load loss is only 800 watts, and the pressure drop 60 volts (assuming the motors to be working at minimum excitation), and consequently their influence in impairing the efficiency or regulation of the system is insignificant. Naturally, it is far better to place the required reactance outside the generators than to design the latter with large reaction and consequent drop.

(To be concluded.)

ACCUMULATOR TRACTION IN ITALY.

The question of electric traction appears to be exciting general interest in Italy, and according to the technical journals, nearly every system is being tried. One experiment of special interest has recently been made on the railway between Bologna and San Felice sul Panaro, a distance of about 26½ miles. In this experiment, the technical details of which were described in a paper read by Signor Lanino before the "Associazione Elettrotecnica Italiana," in October last, the required energy was supplied by accumulators carried in the cars. The line in question serves to connect numerous small agricultural centres with the chief town of the district. The passenger traffic is exceedingly limited, not exceeding a daily average of 180 passengers for all the stations, and the goods traffic is still more limited, the mean daily transactions, including forwarded and received parcels, not exceeding 40. The service of the cars being restricted to the conveyance of passengers, baggage, mails, and express parcels, it is evident that the conditions of the experiment are very different from those which would obtain in an ordinary railway service. The object in view was, in fact, to prove by an experiment carried out on a fairly large scale, whether accumulator traction could be successfully employed under certain favourable and clearly-defined conditions.

The cars are strongly built, and are supported on two four-wheel trucks by means of a triple system of springs. The extreme length of the car is 57·4 ft., and the height of the roof above the rail 12 ft. The distance between the centres of the trucks is 36¾ feet, and the axles of each truck are 8½ feet apart. The car has two compartments, one first class, capable of seating 20 passengers, and one third class, capable of seating 32. These two compartments are separated from each other by the luggage van, 9 feet long, and capable of holding 2 tons of luggage and goods, whilst each of the covered platforms provides standing room for eight passengers. At the ends of the car are the cabs for the driver. These have independent entrances, and are completely separate from the rest of the carriage, but the interior of each is visible from the body of the car, so that the attendants can see what the driver is doing, and go to his assistance, if necessary.

The car was constructed at the works of Diatto Bros., of Turin. It is furnished with two Ganz four-pole motors, excited in series. The commutator is of copper, with mica insulation, and the brushes of carbon. The total weight, including the suspension and gearing, is 1¾ tons. The motors are constructed to give a normal pressure of 500 volts, and are geared to one of the motor axles of the respective trucks with a speed reduction of 1 : 3, the driving wheels having a diameter of 40·2 in. The pinion is of steel, and the toothed wheel of phosphor bronze, the whole being enclosed in a case with oil. The load on the motor axles, when the car is full, is 12·99 tons, and that of the non-motor axles 11·61 tons; the adhesive weight is, therefore, more than sufficient to ensure the starting of the car at any point of the line. Each motor, at the normal speed of 750 revolutions (corresponding to 27·96 miles per hour) and 500 volts pressure, is capable of exerting a tractive force of 882 lbs. at the periphery of the wheels, which may be increased to 1,764 lbs. without risk.

The energy is furnished to the motors by accumulators of the Pescetto type, manufactured by the Società Italiana per Elettricità, late Cruto, of Turin. The size of the plates is 5·75 in. × 8·27 in. the thickness of the positives being 0·256 in. and of the negatives 0·207 in. The positive plates are covered externally with a thin perforated sheet of lead to prevent the efflorescence of metallic lead on the surface itself. These plates are guaranteed by the makers to have a capacity of 9 ampere-hours per kg., and bear a charging current of 6 amperes and a maximum discharge of 4·5 amperes per kg. Each cell consists of eight positive and nine negative plates, separated from each other by corrugated ebonite diaphragms and small glass tubes and enclosed in an ebonite box 8·08 in. × 6·89 × 15·96 in. The connections adopted consist of lead-covered copper strands soldered to the plates by means of capsules, experiments having shown that this system is preferable to the ordinary method. A cell thus made up and filled with acid solution of specific gravity 1·166 weighs 73·6 lbs. The normal discharge is 200 amperes, the momentary discharge may be 500 amperes, and the charging current 80 amperes. The equipment of a car consists of 288 such cells, contained in 12 movable trays, which are carried in spaces left in the under frame of the car between the longitudinal beams and vertical pillars. In order to obtain good insulation much care was necessary in the construction of the accumulator trays, the pressure on the San Felice cars during charging being as high as 750 volts. Moreover, as the cells had to be charged without removing them from

the car, the evolution of gas and projection of liquid particles greatly diminished the insulation of the cells contained in the trays. Artificial ventilation during charging, or partially withdrawing the trays from the cars may reduce this inconvenience, but will not completely obviate it. The type of tray adopted is made of pitch-pine boiled in paraffin, the woodwork being firmly held together by an iron frame or cage. It is further strengthened by iron bars enclosed by the wooden partitions which divide the tray longitudinally, and which support the ebonite boxes of the cells. The latter are arranged in rows of six, being separated from each other by glass plates, and each tray contains four such rows. The bottom of the tray is lined with sheet lead, and the vertical partitions are varnished and covered with glass. It is closed at the top with a cover of wood and glass with movable panels. Each tray is 46·9 in. × 36·7 in. × 15·4 in. externally, and weighs altogether 19 cwt. It may be removed from the car if necessary by means of a suitable truck running on a track of 50 cm. gauge which connects the car shed with the repair shop. A single car carries eight trays of this type, together with four of a larger type, the latter containing, in addition to the 24 power cells, 10 similar but smaller cells for lighting purposes. Each of these smaller cells has a capacity of 135 ampere-hours, and a normal output of 25 amperes, and weighs 45 lbs. The leads from each tray are brought to a distribution board placed in the luggage compartment. This board is fitted with a 12-position switch by means of which any tray can be joined up to a voltmeter, and defective cells thus immediately localised. Such defective cells can be cut out of the circuit without affecting the continuity of the remainder; the lighting cells may be joined up in series with the motor batteries, or rendered independent of them, &c. At this board also the lights of the car, including the head and tail lights, can be turned on or off.

The controller is a double-handled one, and enables all three batteries to be joined up in series or all in parallel. Besides the driving positions, there are on the same cylinder an initial "off" position, and positions for reversing and for putting on the electric brake. The second cylinder of the controller makes the motor connections, which are the usual ones for a series parallel system; that is, motors in series, motors in series with shunted field, motors in parallel, and motors in parallel with shunted field. There are thus eight different running speeds, four with the batteries in parallel and four with them in series. In reality the positions for normal running are only two, namely, motors in series and motors in parallel; the other positions are for starting or increasing speed, and should not be used unnecessarily. The first normal position gives a speed of about 28 miles per hour and the second about 43½. To prevent short circuiting of the accumulators no alteration in the connections of the batteries is permitted unless the motors are cut out of circuit; nor can the driving handle be removed from one controller and placed on another unless both cylinders of the first controller have first of all been brought to the "off" position. To reverse, the accumulator handle and the motor handle must be placed on the first notch. When the electric brake is used the accumulators are cut out, and the motors act as generators working through resistances, thus transforming the kinetic energy of the train first of all into current and then into heat. Ordinarily a Westinghouse compressed air brake is used, a hand brake being held in reserve. For compressing the air required for the Westinghouse brake and alarm whistles, a double cylinder pump, placed in the luggage van, is used. This is worked by means of an endless screw driven by a small motor.

A closed circuit-breaker, placed underneath the car, and actuated directly by the lever of the brake blocks, cuts the motor circuit each time the brake is put on.

As has been already mentioned, the Bologna-San Felice line has a length of 26·4 miles between the terminal stations. It is regular in direction, but has numerous gradients, the steepest being about 6 in 1,000. There are three intermediate stations, where the track is doubled for crossing, and 10 simple stopping places for the use of passengers. The normal speed of running of the cars is about 28 miles an hour, and the whole journey, including stoppages, is, according to the time-table, performed in 1 hour and 20 minutes.

The battery for supplying current to the motors of a car has a capacity of 300 ampere-hours, equal, at a mean pressure of 600 volts, to 180 KW.-hours, with an average discharge of 200 amperes. This capacity was intended to furnish sufficient energy for a complete to-and-fro journey in all conditions of weather: it actually enables the car to run a distance of 62 miles under ordinary conditions.

When the Government sanctions the opening of the service to the public, it is intended to run a car in each direction every three hours. There are altogether four cars, of which two will perform the ordinary service, one will remain always ready charged as a reserve or for special service, and one will be under inspection. The trays of accumulators are interchangeable, and will also be subjected in turn to a monthly examination.

The car shed is provided with a double track with pits, and has the necessary appliances for charging two cars simultaneously on independent circuits. The charging is usually done with the batteries in position, or only partially withdrawn. A system of Decauville tracks of 50 cm. gauge runs along both sides of each car track. These are connected with each other at the end of the shed by means of a traverser, and all unite at the front of the shed in a track running to the repair shops. The accumulators may be transferred to the repair shop by means of a four-wheeled truck, the top of which may be raised or lowered by a system of four parallel screw jacks. The motors with their suspensions and gearing may also be removed by means of a special truck placed in one of the pits.

The charging plant consists of two groups of generators and a switchboard, together with a 3 KW. transformer for lighting purposes. Each generator consists of a six-pole, three-phase asynchronous Ganz motor, giving 42 complete alternations per second, 840 revolutions at no load, 3,000 volts at the primary, and 80 effective horse-power at full load. To this motor is coupled on the same shaft a continuous current dynamo by the same makers, the working pressure of which may be varied at will from 550 to 750 volts. The three-phase current for driving the motors is supplied by the Società Co-operativa di Elettricità, of Bologna, and is directly utilised at 3,000 volts.

The battery was designed to give a tractive force of 17·6 lbs. per ton on the level, and in the absence of wind; but Signor Lanino calculates from the known characteristics of the motors and the current consumed, that the resistance during normal running on the level varies from 9·9 to 6·2 lbs., and from 13·2 to 17·6 lbs. in starting. The experiments, however, from which these figures are deduced, relate to new material in an excellent state of preservation, and to the most favourable conditions of wind and of the line. During the winter the conditions of working may be altogether more unfavourable, and the resistance offered by the wind and snow may become an important factor. The diagrams of running show that in starting there is a consumption of current of about 300 amperes with the motors in series, and of 600 in parallel, the three batteries being in parallel; and that during normal running with the batteries in series, and the motors in simple series, that is, at a speed of about 28 miles an hour, the current is from 60 to 80 amperes, and with the motors in parallel—that is, at 43½ miles an hour—the current is about 200 amperes. If the driver is skilful he can get up the normal speed of 28 miles an hour in less than a minute without exceeding 400 amperes. The average consumption up to the present for a complete journey to and fro has been 120 KW. hours, with a mean of 30 watt-hours per ton-kilometre.

It is unfortunate that Signor Lanino was unable at the time of reading his paper to give any details of the expenditure involved in these experiments, or any estimate of the cost of maintaining the batteries. No idea can therefore as yet be formed as to the success of the experiment from a financial point of view.

THIRD RAIL IN THE BALTIMORE BELT LINE TUNNEL.*

A FEW years ago the Baltimore and Ohio Railroad Company spent about $7,000,000 in constructing a railroad through the city of Baltimore and its suburbs, in order to save half an hour in time, and to secure an all-rail route from the metropolis to the capital of the country. Before the Belt Line was built, passenger and freight trains were carried across the harbour on a huge car ferry named after the founder of the Baltimore and Ohio system, "John W. Garrett." The Belt Railroad cost nearly $1,000,000 a mile to build and equip, owing to the large amount of tunnel construction and other difficulties of the work, also to the fact that it was to be operated by both steam and electric service. It was the first railroad of any importance in the world to utilise large electric locomotives for hauling freight and passenger trains.

The use of electricity was decided upon for the reason that the Belt Line contains several heavy grades, and has some of the sharpest curves of any railroad in the United States. To furnish the current a power house was built, from which the electricity was transmitted by cables to an overhead conduit system, consisting of a metal trough hanging from iron bars, which were in turn supported by metal archways located from 200 to 300 ft. apart. A "shoe," made of cast-iron, slid through the trough, passing the current to the motors by means of an adjustable metal bar, which connected the shoe with the top of the electric locomotive. In the tunnels the conduit was supported from the roof without the necessity of the archways, but it was found that a large quantity of the current passed to outside conductors, in spite of the insulated protection, and this leakage necessitated the generation of much more electric power than has been actually needed to work the motors. The overhead system has also required a considerable outlay yearly for repairs, and for some time past the Baltimore and Ohio management has been considering the adoption of some other mode of electric transmission, especially as it wishes to use electric traction on about 70 miles of what is known as the mountain division in Maryland and West Virginia, where ordinary freight trains require two and three of the largest steam locomotives to carry them over the grades. For the last six months the work of equipping the Belt Line with the third rail, also the sectional third-rail system, has been in progress. In the tunnels and in the vicinity of the railway stations the sectional system is used for a distance of 3½ miles, the third rail covering the balance of the Belt Line. Its installation is similar to the system on the New York, New Haven and Hartford railroad between Boston and Nantasket Beach, but more current is required on the Belt Line. It is conveyed through an extra or feed rail laid about 18 in. outside of the regular track. This weighs between 70 and 80 lbs. to the yard and is bonded by insulated copper cables fastened into the ends of each rail. The current from the power house is also carried to the end of the feed rail by cables which are buried in the ground. The electrical locomotive takes its power by means of a shoe which slides along the top of the rail. Each locomotive has four shoes, fastened, one outside the lower part of each driving wheel, and connected with the locomotive frame by spring attachment that adjusts itself to any deviation in the track, so that the shoe is automatically held

* *Scientific American.*

upon the rail. The sliding shoe is utilised on both the third rail and sectional portions. Only the portion of the sectional third rail, however, is charged with electricity that is covered with the locomotive. It receives its name from being divided into sections controlled by electric switches, which are automatically operated by the movement of the locomotive.

The switches are practically of the solenoid type with two windings, one a fine winding, taking a current of about 550 volts from the generator on the electric locomotive, through the controller, the contact shoes and the third rail. This current raises a plunger, which closes the switch and feeds the power house current of 700 volts to the third rail. The moment the weaker generator current passes through the fine winding and closes the switch, current from the power house passes through the heavy winding of the magnet and keeps the switch closed until the contact shoes of the electric locomotive have passed to the next section. The circuits around the magnet being broken, the switch opens by gravity. The contacts last to operate are of carbon, and the spark, if any, is between these contacts, thus preserving the metallic contacts from injury. At the instant the contact shoe at the forward end of the locomotive comes in contact with the forward section of the third-rail conductor, the switch controlling the feeder for that section closes, and the switch for the rear section opens.

Each of the magnetic switches is provided with a single pole double throw knife switch in series with the fine winding of the magnet. This is used by the inspector to test the magnetic switch and ascertain whether it is in proper adjustment. Should it be necessary to make any adjustment while the section controlled by the switch is in use the current is fed to that section by means of a temporary bridge which he places in position.

In operating the motors, the motorman turns the controller to the first notch, opening the throttle to the air engine, which, taking compressed air from the storage reservoir of the air-brake system, drives an electric generator, which generates sufficient current to operate the magnetic switch and charge the third rail with current from the power house. At the instant the magnetic switch is closed the power-house current passes through it to the third rail, thence through the contact shoe and the controller to the electric generator which operates the switch, and also to the four 300-H.P. motors of the electric locomotives. Immediately and automatically the generator becomes a motor, operated by current from the power house, and drives the air engine as an air compressor, recharging the compressed air reservoir from which the air engine originally obtained its power.

At no time is it possible during the operation of this system to have a charged conductor or third rail except when the motorman has turned the controller, and then only one section is charged, *i.e.*, the section on which the electric locomotive is operating.

The locomotives in use on the Belt Line have hauled by the overhead system two loaded freight trains with their engines, representing about 2,500 tons of weight, unaided by the steam locomotives. This will give an idea of their transmission power. The same amount of current required for this pull has been transmitted by means of the sectional and third rails to the locomotives during the present tests without difficulty. The archways and conduits of the overhead system remain and the locomotives can take current as desired, either from the top or bottom, but the upper construction is to be removed in the near future.

The tests which have been made include the operation of the locomotives at slow, half and full speed with and without loads. They have been switched from one track to another, started and stopped on grade and placed in service to haul a train of 22 45-ton coal cars loaded during a heavy snow storm, the shoes taking current from the rail when covered with snow and ice to the depth of several inches. In adapting the motors for service with the systems, the mechanism was practically unchanged, a few alterations being made to the air compressors and the contact shoes connected.

Both the sectional and third-rail installations were completed under the supervision of Mr. John McLeod Murphy, inventor of the sectional method and chief engineer of the Murphy Safety Third Rail Company.

TESTING CABLES IN THE NAVY.

All electric cables, leads and circuits are tested in the Navy by means of the Minotto type of Daniel cell; there are two batteries used for this purpose, one being the portable single cell with a 20-ohm galvanometer on the top of it, and the other consisting of six cells of which any number may be put into the circuit by a system of brass plugs.

The six-cell test battery is a very efficient and sensitive one. It is provided with a 1,000-ohm galvanometer with astatic needles, and in using it for insulation tests, great care has to be taken that the battery itself is well insulated, that is to say, it must not be placed upon the damp deck, or in any damp place where a small leak might occur between the terminals. An apparent fault in the cables has sometimes been traced to carelessness on the part of the seaman who is carrying out the test, and who has allowed his hand to rest upon one of the terminals, and so form an earth return through his own body.

The chief use of this battery is in all mining and submarine work where a high insulation is necessary.

For gun circuits and short leads above water, the single cell is quite good enough, and is generally used for the "continuity" test.

There are three general tests in the Navy, the first known as "non-contact," that is to say, practically "short circuits," and is chiefly necessary where two leads are bound together, or are in the same casing.

The second test is for "continuity," and is, as the name implies, used to detect any break or great resistance in the circuit that should not be there.

The third test is for "insulation," and needs no explanation.

The manner in which these tests are carried out, is as follows:—The battery itself is carefully tested to start with. A short lead of wire is connected to the negative pole, which happens to be the free terminal of the galvanometer, the other terminal of the galvanometer being in permanent connection with the zinc of the battery; care must be taken that this lead does not touch the brass casing of the galvanometer, of course.

To the positive pole of the battery a short lead, with an earthplate of copper sheeting attached to it, is joined. On touching the end of the first lead to the earthplate there should be a deflection of at least 80° when the key is pressed.

Suppose an outrigger circuit is to be tested; it consists of two well insulated wires bound together at intervals of about 18 in. This circuit, when fitted, runs from a battery in the boat along a groove in the outrigger spar, and so to the fuse in the charge at the end of the spar, a firing key being placed at the battery end.

The first test being for non-contact, the two parallel leads are taken, and the further ends, which will be joined to the fuse, are insulated with rubber tubing, a portion of which, projecting beyond the wire, is bent back upon itself and bound with fine twine.

At the near end one wire is joined to the lead from the negative terminal, and the other is touched to the earthplate; there should, of course, be no swing when the key is pressed. So much for non-contact. The next test in order is for continuity, and for this purpose the two further ends are now joined together with a temporary junction; everything else being the same as before, a violent swing of the needle should ensue.

For insulation, which is the last test, a tub of sea-water is used; the earthplate is put into the water, and, keeping the end which before was touched to the earthplate insulated in air, and the key pressed down, the cable is slowly coiled down into the tub, beginning at the far end.

A swing of the needle will now take place if the temporary junction has not been made properly watertight, and consequently there should be no doubt in this respect; if it has been well made, however, there will, of course, be no swing of the needle unless the insulation is faulty, in which case the fault is easily localised by watching the needle of the galvanometer and gradually lifting the lead out of the water until it swings back, when the fault will be found to be just clear of the water.

Unless very high insulation is required, as in the case of submarine cables, insulating plugs, &c., the single cell is far the most convenient for this test, because with it a large fault can be far more easily localised than with the six-cell battery and its sensitive galvanometer, the reason being that in the latter case a fault might be clear of the water and still give a swing, the current passing over the damp surface of the insulation back to the water.

The actual leads of the outrigger circuit having been tested the fuse is tested for continuity and the temporary junction broken for the purpose of joining up the fuse to the circuit; a good watertight junction must be made in joining up the fuse as this portion of the circuit will be under water when the charge is fired.

At the other end the key is joined in, and before joining up to the firing battery another continuity test for the whole circuit is gone through.

Before use the firing battery itself is tested by being made to bring a quarter of an inch of thin platinum wire to a red heat.

The circuit is then joined up to the battery and considered ready for use.

In testing submarine cables and leads a high standard of insulation is required and the six-cell battery must be used; great care is taken to have this battery in a dry place, and it is usually supported on a sheet of india-rubber.

The battery itself is now tested as before with an earthplate connection, after which the short lead from the negative terminal is joined to the end of the cable to be tested with a temporary junction; it is important that this should be carefully done, as the extreme ends of the insulation outside the armouring are more likely to deteriorate than any other part. The further end of the cable is then insulated and the earthplate touched to the armouring; the six cells are then put in one at a time by means of brass plugs, and the key kept pressed until the whole battery power is in the circuit in series. There should be no perceptible swing. Then to make sure of continuity, while the far end of the core is grasped in one hand and the other touches the armouring, glance at the galvanometer, there will be a considerable deflection if all is correct. This is the test for "non-contact," because the armouring takes the place of a return wire, and the latter part of it, tests for continuity through the body—a convenient natural resistance.

We now come to the "insulation" test, which is carried out in a very similar manner to that used in the case of the outrigger circuit, except that the cable is paid overboard instead of into a tub of water.

Only one cell is plugged up, so that a large fault may be easily localised if it happens to exist. When all the cable is in the water, the six cells are put in and the cable left to soak for a considerable time, to make sure that the insulation is perfect.

A rather ingenious expedient is sometimes resorted to where the continuity of an armoured cable is suspected. The single cell test battery is joined up to the armouring and core with short leads, and at the other end the armouring and core are joined together, the contact key kept pressed and a magnet inserted in front of the galvonometer to steady it. The cable is then coiled

down on the deck, and if the needle becomes disturbed during the process, it indicates the rubbing together of the fractured wires, so that a rough guide as to the whereabouts of the fracture is obtained.

Another little expedient for localising a break is known as the "needle test," but it can only be used with soft insulation. Two needles, as fine as possible, are procured and threaded with fine binding wire; one of these is connected to the negative pole of the single cell battery, and one end of the cable is joined to the galvanometer terminal, or positive pole. The centre of the cable is then found, and the needle forced through the insulation to the core. On pressing the key a deflection will show if this half of the cable is correct, and if so, the other end is tested in a similar manner.

If one half is found to be sound, leaving the needle in the centre, disconnect the cable from the galvanometer, and join up the second needle in its place, force it through midway between the first needle and the end which lies on the defective side. If no deflection occurs, the fault evidently lies between the two needles, and can be found by moving the one towards the other until a deflection *does* occur.

The india-rubber insulation is found not to be seriously damaged by this, so long as the needles are not worked about, but great care must be taken not to break off the point of one of the needles, and thus leave a most troublesome leak, almost impossible to locate without injury to the cable itself. So much for the ordinary tests applied to cables before they are laid out.

Once the minefield is laid, the ends of the cables come into the "testing hut" ashore, where continual balancing, morning and evening, is carried out, and records kept of the efficiency of the whole installation; but that is a special branch of the subject, with which it is not our intention to deal in this present article.

The above methods are simple, efficient, and easily carried out, even in boats, and on them the efficiency of all electric installations in the Navy principally depend.

THE DIATTO SURFACE CONTACT ELECTRIC TRACTION SYSTEM IN PARIS.

The electric tramways in Paris and district, worked on the Diatto surface contact system, are just now the subject of much discussion in the French capital. The cause is to be found in the many accidents that have taken place, the consequence being that the matter of the lines worked on this system has been the subject of consideration at the Tribunal de Commerce, the Conseil de Prefecture, the Prefecture de Police, the Paris Municipal Council, and at the French Ministry of Public Works.

We gather from *L'Industrie Electrique* that as a result of a letter received from the Prefect of Police showing that during the period extending from June 15th, 1900, to February 20th last, no less than 120 accidents had taken place, of which 58, or practically half, occurred in January last—that is to say, during the snowy period—the French Minister of Public Works instructed the Comité d'Exploitation Technique des Chemins de Fer (Committee on the Technical Working of Railways) to inquire into the inconveniences and dangers which may appertain to the Diatto system. This Committee reported that the accidents that had taken place were due to:—

1. Insufficient drainage of the surface contacts and conduits causing shunt currents.

2. To the action of the special contacts fixed fore and aft to the motor tramcars at the moment these contacts pass over the surface contacts.

3. In order to give stability to the latter they have been supported by two metallic cross pieces, joining the tram rails, an arrangement which is very bad from the point of view of the insulation of the surface contacts, and one which has been attended, when the tramlines have been sprinkled with salt after a fall of snow, with most unfortunate results.

4. The sparking which occurs each time the working of the surface contact is not perfectly regular, gives rise to the formation of a conducting deposit of carbon due to the combustion of the material of which the surface contact box is made.

5. Finally the Committee reported that to the bad insulation of the cables, apart from the insufficient drainage of the conduits, many of the accidents are to be attributed. This insufficient insulation, while dangerous to public traffic, is not less so to pipes, buildings, and anything of metallic construction lying near to the tramway lines. Strict precautions are imposed in this regard, on trolley tramway installations, and the Committee consider that similar precautions should not be overlooked in the case of surface contact lines, in which perfect insulation is much more difficult of attainment.

In December last the Prefecture of Police issued instructions to the tramway companies that all the surface contacts must be visited *daily*, and a report sent to the Prefecture within the next 24 hours on the results of the inspection, that the special contacts on the cars must be temporarily suppressed, and that at various points on the lines means of draining the conduits be laid down. An arrangement was also arrived at between the tramway companies and the Street Cleaning Committee of Paris that the tramway lines should not be sprinkled with salt after a fall of snow.

In their report the Committee, without expressing any opinion on the merits of the Diatto system, for or against, approve the action of the Prefecture of Police, and recommend (1) that the tramway companies be requested to establish sufficient space between the surface contacts and the cross pieces above referred to; (2) to take steps on the one hand to suppress the formation of carbon deposits inside the surface contacts, and on the other to improve the defective insulation of the conduits; and (3) that the paving of the road around the surface contacts should always be kept in excellent condition. As a result of the report, the Paris Municipal Council has passed a resolution calling on the tramway companies to carry out the improvements outlined in the report above alluded to before October 1st next.

ISLINGTON ELECTRICITY SUPPLY AND ITS PROGRESS.

Shortly after the transfer of the powers and obligations which were in the hands of the Vestries from the Islington Vestry to the Metropolitan Borough Council in November last, several of the newly-elected councillors, being anxious to know something about the standing and working of the electricity supply department, had a reference remitted to the Lighting Committee, calling for a report upon the undertaking. This report was considered and received at the Council meeting on Friday last.

The Lighting Committee, in its report, gives attention first to the financial results, and states as reasons for the comparatively unremunerative state of the undertaking, the small output, a relatively large expenditure in capital and wages, and the high proportion of street lighting. The small output is due to the delay in starting extension plant, owing to contractors not having completed in the time originally allowed, and the considerable periods, sometimes as much as 10 or 12 months, which have elapsed between the date of application for loans, and the receipt of consent to borrow, these causes having made it injudicious to connect new consumers when the available plant was already overloaded, and, therefore, retarded the growth of the business. Islington is an almost purely shopkeeping and residential district, and does not possess the advantage of a demand for motive power, which would create a day load. Its load factor is, therefore, low. The output in 1899 was 1,346,437 units, of which about half, or 660,212 units, were taken by the 330 street arc lamps, and 686,225 units were sold to private customers. As the price settled by the then Vestry for street lighting was 3½d. per unit, which includes all charges connected with the provision, up-keep and maintenance of the lamps and mains, and all the sums required for interest, &c., on the capital so expended, and as entirely separate mains are laid from the generating station throughout the district for street lighting, this figure is not likely to yield pecuniary profit. The first two lines below are taken from the report; the others are extracted from our analyses of the accounts, published on the dates given in the bottom line.

	Islington.	Shoreditch.	St. Pancras.	Hampstead.
Percentage of output taken by public lighting	50 %	22 %	14½ %	8 %
Amount of net profit	£380	£563	£6,842	£9,357
Gross profit ...	£9,521	£6,138	£17,650	£16,324
Output in units ...	1,346,437	1,630,426	2,477,508	1,418,442
Average received from private lighting	5·33d.	3·18d.	4·48d.	5·14d.
Average received from public lighting	3·50d.	3·36d.	3·46d.	3·40d.
Average received from both public and private lighting	4·43d.	3·23d.	4·29d.	4·98d.
Works cost per unit	2·29d.	2·02d.	2·23d.	2·00d.
Total cost per unit .	2·82d.	2·34d.	2·66d.	2·43d.
Date	June 22/00	Feb. 22/01	July 20/00	Aug. 31/00

From this two conclusions may be drawn, that the net profits at Hampstead and St. Pancras are respectively due to the comparatively high average price received in the one case and the relatively large output in the other. Shoreditch has a small sum to set aside for interest and sinking fund. At Islington, the accounts for 1899 state that

£30,000 of the capital expenditure was unproductive, as this sum had been advanced as part payment on plant not completed. The interest and sinking fund payments had, however, to be met, and the difference between gross and net profit was therefore comparatively large. In the first year of the working at Islington a loss of £1,836 resulted, reduced to £318 in the second; in the third there was a profit of £2,206, and the year 1899 was the fourth, of which we give the result above.

The report then goes on to deal with a popular description of the buildings, machinery, mains and system, and emphasises the provision which has been made to secure safety, ensure reliability and minimise the risk of, and limit the duration and inconvenience from, a fault or breakdown on machinery or mains—a provision which necessarily entailed a higher capital expenditure than would have been incurred had such precautions been omitted. These were described in our columns at the time the Islington works were the subject of an article in March, 1896.

The report closes with a recommendation that mains should not be laid in districts unlikely to prove remunerative, and that extensions of street lighting at its present price should be avoided. Islington adopted the policy in its original scheme of planning a large station and making ample provision for the future: owing to diverse circumstances the coming into being of a large load has been deferred, through no fault of the engineer, and therefore the financial results are not what they will be when the output is commensurate with the means provided to deal with it. Pressure on the part of certain sections of the late Vestry led to the price for street lighting being reduced, and at the same time large expansions in this direction were undertaken, the effect being to absorb the profit derived from the sales to private consumers. St. Pancras is committed to very heavy expenditure on street lighting extensions in the immediate future, and as rumour has it that this Council has only a small profit to show for the past year's operations, while at Hampstead large additions at considerable cost are to be made to the station buildings, it would appear that Islington has only been a little previous, and that there is at work a levelling-up or levelling-down process which will alter considerably the character of the next few years' accounts of some London undertakings.

THE BLACK CITY.

Such is the name by which Sir W. B. Richmond designates London in the *Pall Mall Magazine*. It is not a bad name, for it is fairly descriptive, and it is emphasised by means of pictures that are reproduced from photographs that have been specially taken to illustrate this special article. Photographs are said to represent facts. Now these particular photographs misrepresent them, and appear to have been taken with such lights and such exposure as to convey to the reader the impression of a blackness that has no existence in fact. It is said that art has a good deal of the false about it. As a high priest of art, no doubt Sir W. B. Richmond is entitled to use all the byeways of art to help his article, and he has used light and shade—particularly shade. Thus it seems that by means of screens or of other devices employed by the photographer, the whole atmosphere in these photographic reproductions has been made to convey an impression that does not exist, for, be it observed, all the pictures show clear cut outlines, and were obviously taken when no fog existed, and when, as we all know, London smoke is never so obtrusive as it is on foggy days, for it is when fog hides all things that smoke makers let themselves go, and otherwise clean chimneys become hidden offenders.

The basis of Sir W. B. Richmond's present onslaught is that it is manufactories, not private houses, that make smoke. Our own conviction is that the factories make the black smoke and the houses make the raw or green smoke—the product of distillation, not of combustion. Unfortunately, our well-meaning author does not appear to know his facts sufficiently. For instance, he asks for a system of cumulative fines so as to compel those who defy the law to spend £100 in putting down an automatic coal feeder which does prevent smoke almost entirely. Whence does he derive this positive information?

Also if such an absolute cure is known, why is it we find our author so exhilarant because certain steamboats have adopted anthracite as a palliative, as to which we should like to ask what becomes of the sulphur which is usually a marked impurity in anthracite coal. Unfortunately, Sir W. B. Richmond's methods are wrong. He would fine all smoke out of existence. This could be done readily; let us enact laws that forbid any smoke at all, that impose fines so heavy and so frequent that the manufacturer shall be utterly ruined, and let us import what he now produces from America or from France. We commend this simple remedy.

As to the multitudes who will be left to starve for lack of work, let them live on clean air and sunshine. We do not wish to pose as upholders of smoke, but we do wish to have the interests of manufacturers cared for by an avoidance of injudicious persecution. We do not call it judicious to compel the disuse of the bituminous fuels that constitute the chief of our coal supplies. We should like to see power generated by some better means than small and isolated steam plants. We would recommend our artistic author to have collected the knowledge of the subject. Let it be shown what has been done to burn coal smokelessly. Let the almost universal failure be exhibited and the causes of such failure be explained. Let our author do something towards educating our most successful engineers—in a pecuniary sense—to a sense of the scientific basis that underlies combustion. Let our author use his funds in disseminating a knowledge of the difficulty of smokeless combustion in ordinary furnaces of shell boilers; of its absolute impossibility with the ordinary types of water-tube boiler. Let him have the boldness to publish descriptions of the boilers at various smoky places, to show their smoke-producing faults and to name their designing engineers. Let him show the laws that govern combustion, and finally let him give descriptions of gas power plants and show their economy.

In a gas producer there is no smoke made. With suitable plant residuals may be collected at great profit, or with duplex producers bituminous fuels may be pretty completely gasified with very small production of residuals. The small gas power plant is far safer than the small steam plant, but much harm has been done to the system of gas power by the use of high priced gas. One ton of coal will produce about 10,000 cubic ft. of illuminating gas, and about 12 to 15 cwt. of coke, whereas it will produce about 180,000 ft. of poor gas, of which one-third is combustible. At 2d. per 1,000 ft., a ton of coal in a producer will produce 30s. worth of poor gas which corresponds with a price of 6d. per 1,000 ft. of the combustible portion. Thus a manufacturer who buys bituminous fuel at 15s. per ton, really obtains his gas engine fuel at 3d. per 1,000 ft. of combustible, or at 1d. per 1,000 ft. for gross volume. Now, 1,000 ft. will produce 7 H.P.-hours at least, and the fuel cost per horse-power-hour is one-seventh of a penny. Apart from this there is a certain amount of heat that can often be utilised which results from the cooling of the gases, as well as that which is obtained from the water jackets. There is a good deal of this kind of information to be obtained. We think if it could be brought home to people they could often be induced to give the system a trial. But obviously misleading photographs rather tend to impress people with a sense of an overstated case.

TESTS OF WATER-TUBE BOILERS.

The *Engineer* abstracts some tests made at Paris by M. Niclausse, and published in a paper read at the Congres de Mecanique. Their value lies in the fact that each of the 12 rows of tubes forming the boiler was tested independently with its own feed tanks, gauges, and steam pipes. Coal was burned at rates from 10 to 60 lbs. per square foot of grate, and feed was supplied at 52° F. Thus the trials are not quite

practical, for in an actual boiler the feed would enter the top drum, or in some other way would vary from a uniform temperature. It was found that for nine different rates of combustion there was no change in the proportion evaporated by the different rows of tubes. The total heating surface was 30 times the grate surface. The first three rows of tubes next the fire gave 50 per cent. of the total evaporation. This we consider most significant, because it emphasises the fact that the furnace gases are very rapidly cooled down as soon as they pass between the tubes, and this points out why water-tube boilers are so very smoky, unless provision is made to conserve the heat by means of suitable refractory linings. The first row of tubes evaporated 8¼ lbs. per hour per square foot, with 10 lbs. of coal consumption, and 35 lbs. with 60 lbs. combustion rate. These figures thus show a heat transmission of 155 and 658 B.T.U. per minute per square foot, the tubes being 3·23 in. outside diameter. The first row of tubes accounted for 22½ per cent. of the total evaporation, the last or twelfth row accounts for 3¾ per cent. only. The lowest rate of combustion gave the highest efficiency, namely, 72 per cent., while the efficiency for 60 lbs. combustion rate was 50 per cent. Apart from what we have pointed out above, a lesson to be learned is the necessity of providing a very free inlet and outlet for the lower rows of tubes in all water-tube boilers. This, we know, is often not done. It doubly condemns the long manifold tubes of the Belleville boiler, and explains how the bottom lap so easily blows itself empty, becomes red hot, bends, buckles, or splits. The behaviour of the earliest heating surface simply parallels that of the tubes of a locomotive type boiler, which were shown years ago to do most of their work in the first few inches next the fire-box.

It is for this reason that every endeavour should be made to minimise the efficiency of the lower row of tubes in a water-tube boiler by suitable shields. This is done in the case of the Babcock & Wilcox boiler with so-called Scotch furnace by a lining of fire-brick blocks threaded between, and more or less fully encasing the tubes. This not only reduces their exposed surface, but converts the furnace into one that is better fitted to prevent smoke. In the Weir boiler, which is of small tube type, with tubes of a more vertical order, the inner rows of tubes are thus encased, and form a refractory-lined furnace such as we have always advocated, and there is formed a zone of secondary combustion in a free combustion chamber where smoke is burned or prevented.

No boiler can be smokeless, except with coke or anthracite, where the gases from the grate rise directly between water tubes. Belleville tried to effect smokelessness by a terrific series of commotions in the furnace, but he failed, of course, because of lack of space to effect proper mixture and combustion. The freezing of a man's breath on a frosty day is rapid when the difference of temperature of breath and atmosphere is, say, 76°. Yet the tubes of a boiler are over 2,000° colder than the breath of the furnace. Small wonder then that the chilly first row of tubes is so effectual in cooling the gases below combustion point.

Steel.—The State Department of Washington, through Consul Nelson, at Bergen, reports the success of experiments in Sweden to produce steel by electricity. Writing under date of January 10th, the Consul says :—

The experiments are being carried on at Gysinge factory, Sweden, and about 25,000 lbs. of steel are produced in six drafts daily. The steel is of an excellent quality and meets with ready sales at high prices. On account of the relatively cheap method of production the profits are large, but as the electrical power is limited the output is insignificant. To overcome this drawback plans have been formed for the erection of a large electric plant near the Dalalafuen river, the water power of which will be utilised. This will enable the company to carry on the manufacture of steel by electricity on a large scale.

Our American Exchange, the *Age of Steel*, makes the following observations on the matter :—

The idea is not new, for electricians have spoken plainly on its practicability. This may or may not mean a radical change in present processes. It is significant, however, of what is yet possible, and of the fact that as science leads the way, the industrial world has sooner or later to follow. There is no such thing as finality in the history of industry, for all that, however, the prophet sometimes rides on the animal that Balaam saddled.

NEW PATENTS AND ABSTRACTS OF PUBLISHED SPECIFICATIONS.

NEW PATENTS, 1901.

Compiled expressly for this journal by W. P. Thompson & Co., Electrical Patent Agents, 322, High Holborn, London, W.C., and at Liverpool, Manchester, and Birmingham, to whom all inquiries should be addressed.

6,757. "An improved electric fire alarm which might also be applied to notify overheated bearings in machinery." E. Barnard and H. G. Stedman. April 1st.

6,760. "Improvements in electrical switches." A. D. Smith. April 1st.

6,770. "Improvements in alarm apparatus for engine room telegraphs or the like." A. W. Higgs and The Anti-Collision Alarm Telegraph Company, Limited. April 1st.

6,780. "Improvements in vessels for use with electrical liquid resistances." H. Hirst and H. Bevis. April 1st.

6,851. "Improvements in or relating to electric lamp shade holders." C. W. Kemp. April 2nd.

6,862. "Improvements in apparatus for generating electric current and in means for registering its consumption." S. H. Holden. April 2nd.

6,870. "Coin-controlled apparatus for telephones." E. G. Lewis. April 2nd. (Complete.)

6,884. "Improvement in protecting covers for steam pipes, water pipes, rods, chains, wire ropes, or electric wires for ship purposes." C. E. Hudson. April 2nd. (Complete.)

6,898. "An electric racecourse." W. G. King. (E. P. dal Pozzo, France.) April 2nd.

6,910. "Improvements in or relating to starting and controlling electromotors." W. S. Boult. April 2nd.

6,933. "Improvements in or relating to prepayment electrolytic electricity meters." B. North. April 2nd.

6,935. "A new or improved method and of means for passing a known fraction of an electric current through an electrolytic meter." B. North. April 2nd.

6,946. "Improvements in automatic telephone exchanges." H. J. Haddan. (The Strowger Automatic Telephone Exchange, United States.) April 2nd. (Complete.)

6,947. "Improvements in the suspension of conducting wires." C. de Kando. April 2nd. (Complete.)

6,949. "Improvements in audible electric telegraphy." R. Oxlade and W. J. W. Richardson. April 2nd.

6,998. "Improvements in the method of and apparatus for adjusting the points of electric tramway lines and the like." J. T. Noble. April 3rd.

7,018. "Improvements in or relating to arc lamps and the like." W. Rowbotham and K. A. Rowbotham. April 3rd.

7,015. "Improvements in the suspending mechanism for electric arc lamps." The Jandus Arc Lamp and Electric Company, Limited, B. M. Drake, and A. D. Jones. April 3rd.

7,016. "Improvements in or relating to electric arc lamps" The Jandus Arc Lamp and Electric Company, Limited, and A. D. Jones. April 3rd.

7,040. "Improvements in or relating to safety devices applicable to overhead trolley wires for electric railways and tramways." C. Hyde. April 3rd.

7,054. "Improvements in systems of electrical distribution." (Date applied for under Patents, &c., Act 1883, Sec. 103, September 6th, 1900, being date of application in United States.) N. W. Storer. April 3rd.

7,067. "Electro-mechanical interlocking apparatus of the safe operation and control of railway signals and points." W. R. Sykes. April 4th.

7,076. "Improvements in time switches for electric signs." S. Fildes. April 4th.

7,086. "Improvements in electro-dynamic equipments." C. A. Carus-Wilson and J. S. Warner. April 4th.

7,113. "Improvements in apparatus for rectifying alternating electric currents." The British Thomson-Houston Company, Limited. (C. M. Green, United States.) April 4th. (Complete.)

7,114. "Improvements in electric regulators." The British Thomson-Houston Company, Limited. (A. R. Everest, United States.) April 4th. (Complete.)

7,115. "Improvements in trolley stands for electric railways." The British Thomson-Houston Company, Limited, and F. Samuelson. April 4th.

7,118. "Improved electric motors." F. de Mare. April 4th.

7,136. "Telephone metering system." D. M. Bliss and N. H. Holland. April 4th. (Complete.)

7,150. "An improved electro-magnet motor." L. H. Engelhardt, H. M. McNolly, and M. Gallert. April 4th. (Complete.)

7,196. "Improvements in electro-magnetic devices for controlling the rotation of shafts." J. Y. Johnson. (P. V. April and The Société Marinier Navoit and Jeanson, France.) April 4th.

7,224. "Improvements in apparatus employed for covering telegraph cables and wires with lead or other metallic substances for electric purposes or for manufacturing metallic pipes or tubes, or like uses." E. A. Claremont and J. Stratton. April 6th. (Complete.)

7,248. "Improvements in, and in the method of and apparatus for, the manufacture of air damping appliances for electric measurement instruments and the like." A. M. Clark. (Hartmann & Braun, Germany.) April 4th.

ABSTRACTS OF PUBLISHED SPECIFICATIONS.

Copies of any of these Specifications may be obtained of Messrs. W. P. Thompson and Co., 322, High Holborn, W.C., and at Liverpool, Manchester and Birmingham, price, post free, 9d. (in stamps).

1899.

11,189. "Improvements in dynamo-electric machines." W. L. Wise. (The Actien Gesellschaft Elektrioitatswerke vormals. O. L. Kummer & Co.) Dated May 29th, 1899. Distortion of field preventing: To prevent distortion of the magnetic field and consequent sparking in continuous-current machines each of the poles may be formed on the leading side with one or more cuts or slits or the face portion may be constructed in two parts, one of which is integral with the pawl or core, while the other is attached thereto, thereby increasing the magnetic resistance on the leading side. In the latter case, the contact surfaces of the parts may be oblique to the axis of the pole, and the parts may be of less magnetic permeability than the other part, so as to obtain the proper distribution of the lines of force; the trailing as well as the leading pole-piece may be made detachable, and the two may be reversible. These forms of poles may also be used in alternators. 7 claims.

11,272. "Improvements in rotary transformers and synchronous motors." R. Belfield. (B. G. Lamme.) Dated May 30th, 1899. To render the action of rotary transformers and synchronous motors more uniform, the pole-pieces of the field magnets are surrounded with a copper ring, and have the corners covered with copper shields. 2 claims.

11,456. "Improvements in contact boxes for electric tramways and the like." C. K. Mills. (E. Bonnet.) Dated June 1st, 1899. Electric railways and tramways on a road contact system, specially those with switches worked by magnets on the vehicle. Conductors; switches.—The plunger which is lifted by the vehicle magnet to complete the circuit, work in a mercury cup, and the mercury in this cup is connected by the rod and second mercury cup to the feeder. The contacts on the plunger and fixed below the surface plug may be of carbon, and are enclosed in a box formed of two parts, with an india-rubber joint or a liquid joint. A flexible chamber, which may be formed as a ring communicates with the interior of the box to maintain equilibrium of pressure. The lower connection is also protected from wet by the bell. The bottom end of the plunger may be of copper and flexible connections may replace the mercury cup. 4 claims.

11,506. "Improvements in carbons for electric arc lamps." J. A. Fleming. Dated June 2nd, 1899. Incandescent arc lamps.—An ordinary arc lamp is provided with carbons oblong in section, one of them having two holes in it to receive loose refractory rods which are caused to bear against the solid carbon by gravity or springs. The refractory rods may be made by submitting pure (dry) magnesia to great pressure in tubular moulds, and afterwards highly heated in an electric furnace. The hollow carbon may be moulded of oval section, and afterwards ground down to reduce the amount of carbon at the sides. In operation, the exposed parts of the refractory rods are maintained incandescent by the arc, which remains steadily between them. The Provisional Specification mentions the use of more than two refractory rods in one carbon. 1 claim.

11,513. "An improved self-acting mule with electrical driving-gear." W. Bretschneider and C. W. Lauth. Dated June 2nd, 1899. Mules.—Reference is made to Specification No. 13,599, A.D. 1897. The tin-roller shaft and the rim shaft are driven independently by several electric motors. The motor loose on the tin-roller shaft may be connected with the shaft directly for spinning by the clutch, and indirectly for backing-off by the gearing and clutch. The motors may be fitted with suitable fly-wheels, &c. 1 claim.

11,657. "Apparatus for forming plates of secondary batteries." H. Leitner. Dated June 5th, 1899. Relates to apparatus for forming plates or electrodes so arranged that the expansive force of the active material during its change into peroxide is utilised for subjecting the plates to great pressure while they are being formed. It consists of a strong box with one end open to receive an adjustable closing-block. Inside the box there is a lining of thick soft rubber, and inside this lining at each end is fitted a block and a thick rubber pad. The positive and negative plates are placed alternately between these pads, and between the adjacent plates there is a separating piece of porous material, such as porcelain, with vertical holes extending throughout its length to facilitate the circulation of the electrolyte. Under the plates and at each side of them are placed grooved wooden blocks. Above the plates a covering-piece is fixed between the conducting lugs by metal bands which extend around the box. On the bands is mounted a cross-piece through which pass set-screws to press down the cover. The block is adjusted by a hand screw, so as to cause the requisite amount of pressure to be exerted. During discharge, the pressure on the plates is maintained by the resiliency of the pads. 3 claims.

11,678. "Improvements in electrolytic apparatus for extracting metals lighter than the electrolyte." W. P. Thompson. (H. Becker.) Dated June 5th, 1899. Sodium, potassium, &c., obtaining electrolytic apparatus for extracting metals, such as sodium and potassium, lighter than the electrolyte are formed of a metal vessel having a central depending pipe, which can be cooled by a refrigerating-jacket or other means. Through an insulating stopper is passed a rod supporting the cathode, which may be cut away so as to form a kind of three-pronged fork projecting upwards. The anode is an annular piece or pieces of agglomerated retort carbon or metal, and is supported by a rod or rods. Above the cathode, and projecting slightly beyond it, but not so far as to be above the anode, is a conical or other shaped collector, having a central tube a discharge tube, and a rim rising above the electrolyte. The collector is connected by a resistance to the negative conductor, so as to form an auxiliary cathode. The upper surface of the conical collector is kept cool either by the air or a refrigerating-jacket. The electrolyte consists of the carbonate of the metal desired mixed with alkaline or alkaline-earth salts, or a mixture thereof. The electrolyte is fused by means of the current. The light metal set free collects under the cone, and runs away through the tube. If it is desired to collect the gases given off at the anode, the cell is provided with a suitable collecting cover. 3 claims.

11,682. "Improvements in electric switch." T. H. Marsh and A. Vandam. Dated June 5th, 1899. In tumbler switches, the moving shoe carrying the contact bridges is made of insulating material, such as porcelain, and is grooved for receiving the end of the handle. The contact-piece is bent up at the end to embrace the shoe, and has turned-up strips fitting on the spindle. It is thus held without screws. 2 claims.

11,693. "Improvements in apparatus for connecting branch circuits to electric mains." Callender's Cable and Construction Company, Limited, and T. O. Callender. Dated June 5th, 1899. In electric junction boxes a plug switch is provided for connecting the branch to the mains. The bared ends of the negative conductor and the neutral are connected by bridge-pieces, the latter being also connected to the bared end of the branch. The bridge is connected to a contact-ring, and the end of the branch to another ring above. The connecting-plug is in two parts, and carries a contact-plug and a contact-ring, these being connected through a fuse. 3 claims.

11,747. "Improvements in telephones, phonographs, and such like apparatus." A. S. Bowley. Dated June 6th, 1899. Diaphragms for telephones, phonographs, and similar sound recording and reproducing instruments are made of comparatively thick material, and are held in position by hollow rubber or other rings, filled with air or other fluid under pressure. The diaphragms have a domed, pyramidal, or equivalent raised portion, carrying the style, &c., either formed from the diaphragm or attached thereto. Two such diaphragms may be connected by a pivoted lever and links. 1 claim.

11,776. "Improvements in or in connection with means for supplying current to electrically-propelled vehicles." H. Dalter. Dated June 6th, 1899. Electric railways and tramways on a road contact system with switches thrown by electro-magnets carried by the vehicle. Conductors, switches, collectors.—Two studs, separated by non-magnetic material, when excited by the magnets attract the armature, which is mounted on the short arm of a pivoted lever, and bring the carbon block on its other end up to a contact which is connected with the feeder. The switch is enclosed in the box, to which the feeder is secured by a screw junction in the insulator, the opposing faces of box and insulator being ribbed as shown. The collector consists of long shoes, with magnets excited by the main current or by a battery. Lighting.—Vehicles are lit by two sets of lamps, one supplied from the battery, and the other from the conductor, when the vehicle is at rest or in motion respectively. 6 claims.

11,780. "A new or improved mould for casting plates or grids for secondary batteries." W. A. Gent and S. Jevons. Dated June 6th, 1899. Relates to a mould for casting plates or grids of the shape described in Specification No. 7,321, A.D. 1899. The plate or grid consists of a number of parallel bars connected together by cross pieces, which alternately pass from the top of one bar to the bottom of the next, and *vice versa*. It is in two parts hinged together, and when they are closed together the bars are cast in the recesses, and the strips are formed in the spaces between the two parts. The open spaces in the grid are formed by the pieces. 3 claims.

11,843. "Improvements in devices for starting electric induction motors." The British Thomson-Houston Company, Limited, and The Union Elektricitats Gesellschaft and A. P. Lake. Dated June 7th, 1899. Motors, alternating-current.—The secondary or induced winding of an induction motor has variable self-induction coils arranged in parallel with the starting resistances, so that the currents passing through the latter may be varied without any change in the connections when the motor has got up speed. The variation may be produced by the movement of solid or laminated pieces of magnetic material, with which the self-induction coils are provided. 1 claim.

11,880. "Improved portable electric drilling machine." A. L. Cronean. Dated June 7th, 1899. A portable electric drilling machine for drilling ships' decks, floors, bridges, plates, &c., has a frame with heels and handles. The front end is supported by electro-magnets, between which the drill spindle is mounted. The magnets hold the machine to the work. The spindle is driven from a motor through an elastic coupling. A starting and regulating commutator is provided within the reach of the operator's seat. 2 claims.

11,881. "Electrical apparatus for effecting rotation at a distance." A. L. Cronean. Dated June 7th, 1899. Apparatus for controlling movements at a distance, such as a rudder or turret. The switch controlling the motor is adapted to take up certain positions, and when the motor has moved the object, a second switch cuts out the motor. The general arrangement of the conductors, &c., are as follows:—The controlling-switch may be set on either of the contacts, and supplies current through one of the contacts to either the bar or bars of a sliding switch. The current flows through the contacts to magnets. The switches are rocked, and the motor armature circuit closed, through the rod, contacts, and resistances. As the rudder or other object moves, it operates the sliding switch, cutting out the resistances if required, and finally opening the motor circuit when the insulating part of the sliding bar reaches the contact. At the same time the contact makes contact with one of the contacts, lighting up one of the lamps to indicate the position of the object. A resistance is thrown into the circuit when the motor is cut out, to prevent injury to the generator. 2 claims.

11,901. "Improvements in electrical brush holders." W. J. Poole. Dated June 8th, 1899. Brush holders.—A carbon brush is held firmly against a metal plate forming part of the holder, by means of a loose plate supported in an inclined position between the surface of the brush and projections on the holder, and acted on by a screw which tends to bring it into a horizontal position. A spring washer between the projection and the head of the screw permits of expansion or contraction of the parts due to changes of temperature. The metal plate is supported by a foliated spring and link bars, so as to ensure an approximately straight line movement in the direction to take up wear. 2 claims.

11,930. "An improved electrolytic apparatus." T. Michel, I. Wilhelm, and H. Richard. Dated June 8th, 1899. Alkalies and chlorine, obtaining.—Relates to electrolytic apparatus specially intended for electrolysing alkaline chlorides, and more particularly sodium chloride, to obtain soda and chlorine. The cell is divided into two fluid-tight compartments by a partition. The former compartment contains an anode and brine, and the latter a cathode and a dilute caustic soda solution. An intermediate electrode, consisting of a travelling endless gauze band passing around rollers, passes alternately through the two compartments in the direction indicated, and dips into a mercury seal at the lower end of the partition, which is arranged in a well formed in the cell. A partition having a rubber strip bearing against the gauze, cuts off any upper communication between the two compartments. When in use, chlorine is liberated in the compartment and escapes by the outlet, while the mercury carried by the intermediate electrode forms an amalgam with the sodium. This amalgam is then carried to the compartment and decomposed, hydrogen being evolved and escaping through the outlet, caustic soda forming, and mercury passing back to the well. The electric energy resulting from the decomposition of the amalgam contributes to the electrolytic work. Inlets and outlets are provided for connecting up several cells, and for circulating the liquids. 3 claims.

11,983. "Improvements in attachments for collectors in electric tramways with slotted conduits." M. H. Smith. Dated June 8th, 1899. Electric railways and tramways on the conduit system. Collectors.—The shank of the collector working in a conduit is supported in the casing in which it can swivel within limits allowed by lugs and springs. The casing is supported by parallel-motion arms with adjustable springs, or counterweight from the vehicle frame, or from a vertical axis thereon to allow lateral play as well as vertical motion. According to the Provisional Speculation, the collector may be in two parts with a swivelling connection. 3 claims.

11,984. "Improvements in poles for supporting overhead wires in electric tramways." M. H. Smith. Dated June 8th, 1899. Posts for the overhead conductors of electric tramways are formed with a central tube surrounded by, preferably, four smaller tubes, secured in spacing-collars either by screw joints of various pattern or by tie-rods passing through the smaller tubes. The main tube is secured by a foot-plate buried in the ground, and an enlarged protecting socket partially set in the ground, through which the post passes. The supporting arms at the top are secured by stays, and may be spreading ornamental branches, some of which may carry lamps. 3 claims.

11,985. "Improvements in overhead conductors for electric tramways." M. H. Smith. Dated June 8th, 1899. Electric railways and tramways with overhead conductors. Conductors.—At bridges, or elsewhere where temporary gaps or breaks are required in the overhead conductors, they are mounted on cantilevers, sliding arms, or the like, which can be operated by gearing or otherwise. The conductors are carried by insulators on the ends of counter-weighted arms or frames, and the conductors are attached to trussed bars, which slide on rollers in channel guides on the adjacent posts. Locking devices may hold the parts closed, and insulated underground conductors bridge the gap when opened. The Provisional Specification mentions a tube instead of the trussed bar. 1 claim.

12,114. "Improvements in electrically-driven fans." W. H. Scott. Dated June 10th, 1899. Centrifugal fans, driven by electric motors are especially suitable for use for ventilation and forced draught on board ship. In order to shorten the motor, and to carry it as far as possible into the centre of the fan to obtain the best cooling effect, a multipolar or gramme ring armature is employed, as with either of these the bearing can be carried up into the centre of the armature. For starting and controlling the motor, the switch, which is contained in a part of the fan and motor frame, is employed. The ends of the coils of the field magnets, as well as the brush connections and the terminals for the main leads, are joined up to two parallel rows of spring contacts. Between these the cylinder is rotated, the cylinder being mounted with metal strips, such that in its various positions the circuit may be open, or the magnet coils placed in series, or two in series or two in parallel, or in the fourth position the four coils all in parallel. The box containing the controller communicates by an opening with the interior of the motor casing. 3 claims.

12,165. "Improvements in electric motors." W. J. Still. Dated June 10th, 1899. Relates to electric motors, more particularly adapted for vehicle work, in which the field magnets and the armature both rotate in opposite directions. The field magnets are supported by extensions of their poles on non-magnetic discs journalled on the armature shaft. At one end of the motor the disc is connected through a universal joint with a supplementary shaft. The shafts, which rotate in opposite directions, are caused to drive the rear wheels of the vehicle in the same direction by chain gearing, the gearing at one end being provided with an idle wheel, so as to reverse the motion. The motor is supported from the frame by means of pivoted hangers. Current is supplied to the field magnets by brushes bearing on slip rings in connection with the field coils, and to the armature by brushes bearing on slip rings in connection with a pair of brushes which revolve round the commutator. The holders for the revolving brushes are weighted at their outer ends, so that by centrifugal action the inner ends are kept pressed on the commutator. 5 claims.

12,279. "Improvements in electric telegraphs for ships and other purposes." Evershed & Vignoles, Limited, and S. Evershed. Dated June 13th, 1899. Order apparatus for ships and other purposes, based on that described in Specification No. 8,784 A.D. 1891. The transmitter is a divided resistance switch, arranged to supply current from one pole of a battery to two conductors in varying ratios. A common return conductor leads to the other pole of the battery. The resistances may be equal, and connected in series between the two conductors, the switch arm moving along them, and also including more of an auxiliary resistance in circuit as it moves away from a middle position to reduce the total current; or the switch arm may move along two series of resistances, each connected at one end to one conductor, and arranged in steps of increasing resistance to the other end, to keep the total current constant. The switch arm may move circularly on a numbered or order dial, and be provided with a latch, which is linked to a plain switch on the switch spindle, so that the battery circuit is opened when the switch is locked. 4 claims.

12,417. "Improvements in supports for conductors for electric railways." W. R. Wynne. Dated June 14th, 1899. Electric railways and tramways with overhead or other conductors. Conductors, supports for.—The wire is received in a recess in the under side of the ⊥ shaped piece, and clamped by the lower part, which is shaped on its under side to conform with the conductor, and to afford a continuous tread for the trolley. The two parts are secured by split pins or otherwise, and the device may be mounted to rise and fall in the supporting arm, &c. 2 claims.

"Electrical Review" List

HIGH PRES

PLACE.	Lighting Authority.	System of Transformer Distribution.	Boilers.	Type and Size of Engines.	Type of Generators.	Size of Generators.	Syst of Drivi
PROVINCIAL.							
(1) Aberystwyth ..	Aberystwyth and Chiswick E. S. Co., Ltd.	House trans. and low pressure	3 Economic	3 vert. com. Browett-Lindley, 75 i.h.p., 1 53 i.h.p.; 2 Peache	4 Johnson-Phillips, 2 Brush arc	2 50 kw., 2 45 kw., 2 55-arc lighters	Rope, and rect
(2) Altrincham	Altrincham Electric Supply Co., Ltd.	Transformers in houses	5 Lancs. ..	2 200 h.p., 2 100 h.p., 1 400 h.p., Browett-Lindley	5 Edison-Swan	2 120 kw., 2 60 kw., 1 30 kw., 1 240 kw.	Direct and r
(3) Ayr	Corporation	Sub-stations	4 Lancs. ..	2 horiz. 175 h.p., Marshall; 1 50 h.p., 2 25 h.p., and 2 350 h.p. vert., Belliss	5 Siemens	2 200 kw., 2 100 kw., 1 25 kw.	Direct
(4) Bath	Corporation	Sub-station and house trans.	4 water tube	4 vert. Brush, 150 h.p.; 2 Pollitt & Wigzell, 500 h.p.	4 Mordey rope-driven, 2 300 kw. E.C.C. direct-driven	4 75 kw., 2 300 kw.	Rope dire
(5) Beckenham	District Council.....	Sub-stations, 3 wire dist.	3 B. & W...	2 200 h.p., 1 100 h.p., Belliss	Fowler.....	2 120 kw., 1 60 kw...	Direct
(6) Bedford	Corporation	Sub-stations, 3 wire distributors	7 B. & W., 2 Lancs.	Com. vert., 2 Belliss, 55 h.p.; 2 150 h.p., 1 260 h.p., 2 500 h.p., Allen	2 Johnson-Phillips, 2 Siemens, 3 Fynn	2 30 kw., 2 90 kw., 1 150 kw., 2 250 kw.	Direct
(7) Blackpool	Corporation	Sub-station ..	5 Galloway, 2 Fraser mar., 5 B. & W.	1 400 h.p., 2 200 h.p., 2 100 h.p., Fowler; 1 500 h.p., Ferranti; 2 250 h.p., 1 100 h.p., 2 1,000 h.p., Parsons turbines	Leeds and London, Ferranti, E.C.C., and Parsons	1 300 kw., 1 200 kw., 2 100 kw., 3 50 kw., 2 125 kw., 2 650 kw.	Rope direc
(8) Bolton ‡	Corporation	Sub-stn. and house 3-wire D.C. & trac.	9 Lancs., with superheater	2 1,000, 2 500 i.h.p., Musgrave vert. com.; 4 350 i.h.p., Hick-Har.; 1 200 i.h.p., Wood's vert. com.	Mordey, Ferranti, and Mather and Platt	4 200 kw., 2 100 kw., 1 50 kw., A.C.; 2 600 kw., 2 300 kw., D.C.	2 ro and direc
(9) Bournemouth ..	Bournemouth & Poole Elec. Sup. Co., Ltd.	Sub-station ..	10 B. & W.	10 Brush, universal and marine type	Mordey	2 400 kw., 1 150 kw., 2 100 kw., 3 60 kw.; and 2 100 kw., D.C.	Ropes direc
(10) Bray (Ireland)..	Urban District Council	Sub-stations and house transformers	1 loco., 100 h.p.; 1 Ln., 200 h.p.	1 120 i.h.p., Brush; 1 120 h.p., Robey; 1 130 h.p., Easton-And.; 2 30 h.p., 2 20 h.p., Victor tur.	Kapp and Easton-Anderson-Goolden	2 60 kw., Kapp; 1 75 kw., E.A.G.	Belts a direct
(11) Bristol ‡	Corporation	Sub-stations & 3 wire dist., D.C. 3 wire	Lancs. and Babcock	2 150, 4 350, 4 700, 2 250, 6 100 h.p., Willans	Siemens and Ferranti	2 88 kw., 4 400 kw., 4 210 kw., 2 165 kw., 6 52 kw.	Direct
(12) Burton-on-Trent	Corporation	Street transformers	6 Lancs. ..	Horiz. com., 3 140 h.p. each, 1 300 h.p.	Lowrie-Hall	3 80 kw. each, 1 220 kw.	Rope a direct
(13) Cambridge	Cambridge Electric Supply Co., Ltd.	Sub-stations, 3 wire dist.	4 Lancs. ..	7 Parsons turbines.....	Parsons	—	Direct
(14) Cardiff.....	Corporation	Sub-stations	7	2 65 b.h.p. comp., 2 275 b.h.p. trip., 1 500 i.h.p. comp., 1 500 i.h.p., 3 crank compound tandem	5 Siemens disc armature, and 1 Ferranti flywheel	2 40 kw., 2 180 kw., 2 300 kw.	Direct
(15) Carlow†	Alexander's Electric Works	Cur. con. dir. by a rotary converter	Water tube boiler	Belliss engine 110 i.h.p., 2 turbines 60 h.p., 1 water wheel 30 h.p.	E.C.C. alternators at Milford	1 65 kw., 1 50 kw., A.C.; 1 30 kw., D C	Belt ..
(16) Chagford	Chagford and Devon Elec. Light Co.	Sub-stations	—	Water-wheel, 14 ft. diameter, 14 ft. wide	Siemens	2 22 kw.	Belt ..
(17) Chatham	Chatham, Rochester & District	Sub-chambers in streets	3 B. & W.	2 200 i.h.p., 1 100 i.h.p., Marshall; 1 180 i.h.p., Robey; 1 750 h.p., Parsons turbine	2 Brush and 2 Ferranti alternators, 1 Parsons	2 125 kw., 1 100 kw., 1 50 kw., 1 500 kw.	Rope, b and rect
(18) Chelmsford	Chelmsford Electric Lighting Co., Ltd.	Sub-stations	2 Lancs., 2 water tube	1 225 h.p., 2 140 h.p., 2 120 h.p., 1 40 h.p., Willans; 2 40 h.p., Peache	Crompton	1 160, 2 80, 2 70, 1 20 kw., A.C.; 1 55, 2 28, 2 12 kw., D.C	Direct
(19) Cheltenham....	Corporation	Sub-stations	3 Galloway, 4 Babcock	2 80 h.p., 1 180 h.p., Willans; 2 180 h.p., 2 360 h.p., Belliss	Siemens	1 33 kw., 3 110 kw. 2 220 kw.	Direct
(20) Coatbridge	Scottish House to House Electric Co.	Sub-stations, 2 & 3 wire dist.	2 Lancs. ..	3 vertical marine, 100 h.p. each; 1 vertical marine, 75 h.p.	Mordey	3 50 kw., 1 37½ kw.	Rope
(21) Coventry	Corporation	Street boxes & sub-stations	Lancs.	3 horiz. com. 100 h.p., 200 h.p., and 400 h.p., 1 400 h.p. vertical	Fowler & Co., and Fynn	1 50 kw., 1 100 kw., 2 200 kw.	Rope ar direct
(22) Croydon	Corporation	Sub-stations	Davey-Pax., B. & W.	3 200 i.h.p., 2 400 i.h.p., 2 800 i.h.p., Belliss	British Thomson-Houston ..	1 75 kw., 3 120 kw., 2 250 kw., 2 500 kw.	Direct
(23) Derby ‡.....	Corporation	Sub-stations, for street ltg.	6 Lancs., 2 B. & W.	2 1,000 h.p., Ferranti; 2 250 h.p., 2 100 h.p., 3 50 h.p., 3 30 h.p., Browett-Lindley	Siemens and Ferranti; Siemens D.C. arc lighters	2 600 kw., 2 150 kw., 3 60 kw., 2 28 kw., 3 18 kw. arc	Direct
(24) Dover ‡	Dover Elecy. Supply Co.	Street boxes	Water tube	Brush vert. com. 84, 135, 2 175 i.h.p., and 1 260 h.p.; M'Intosh & Seymour for tramways	Mordey, and G. E. dynamos for tramways	1 50 kw., 1 75 kw., 2 100 kw., and 1 150 kw.	Direct
(25) Dublin	Corporation	Sub-station ..	4 water tube 2 marine	1 400 h.p., Willans; 1 400 h.p., 1 100 h.p., Fowler; 3 250 h.p., Coates; 3 60 h.p., Brush	E.C.C., Fowler, British Thomson-Houston, Brush	2 200 kw., 3 150 kw., 1 50 kw., and 3 Brush arc lighters	Direct and ro
(26) Ealing	Urban District Council	Sub-station ..	6 Lancs. ..	11 Browett-Lindley; 2 45[illegible] h.p., Belliss	Siemens	2 131 kw., 2 60 kw., 2 28 kw., 3 18 kw., 2 10 kw., 2 300 kw.	Direct
(27) Eastbourne ..	Eastbourne Corporat'n	Street and house transformers	2 loco., 2 econ., 2 water tube	1 250, 1 60, 1 50 h.p., Fowler; 1 200 h.p., Marshall; 1 260 h.p., Peache; 1 100 h.p., 1 350 h.p., Willans	E.C.C. and Fowler	1 50 kw., 2 70 kw., 1 100 kw., 1 150 kw., 1 250 kw.	Rope ar direct
(28) Eccles†	Corporation	House trans. & sub-stations	Lanc.	2 200 h.p. vertical, Browett-Lindley	Johnson & Phillips	2 120 kw., 1 25 kw. motor altrnatr. and accumulators	Direct couple
(29) Exeter	Corporation	Sub-station	5 water tube, 1,200 h.p	2 com. hori. 150 h.p., 1 do 80 h.p. 1 com. v. 200 h.p., 2 tri. ex 25 h.p., 1 v. 200 h.p., 1 v. com. 400 h.p.	Brush, Easton-Anderson, Thomson-Houston and Ferranti	2 75 kw., 1 50 kw., 2 100 kw., 1 250 kw. alt., 2 30 arc lgt.	Rope, be and d rect
(30) Fareham	Urban District Council	Sub-station & house trans	2 loco., 1 econ.	1 105 h.p., 1 75 h.p., 1 40 h.p., 1 95 i.h.p., Peache	Thomson-Houston, Johnson and Phillips	2 35 kw., 1 50 kw. alt., 2 30 light arc	Blts., rop & dire
(31) Halifax	Corporation	Sub-stations	4 Lancs., 2 B. & W.	1 100 i.h.p., 2 200 i.h.p., 1 600 i.h.p., 1 600 i.h.p., (3 1,900 h.p.	E.C.C.	1 50 kw., 2 100 kw., 2 200 kw., 2 350 kw.	Rope ar direct

List of Electricity Works of the Un

RESSURE ALTERNATING CURREN

Generators.	System of Driving.	Condensing or Non-condensing.	Type of Mains.	No. of Arcs and equiv. 8 c.p. Incandescents used in Private Lighting.	Number of Lamps used in Street Lighting; Arc and Incandescent.	Number of 8 C.P. Lamps added during past 12 months.	Price Charged to Private Consumers.	System of Charging.	Type of Meters Employed on Consumers' Premises.	Present actual Capacity of Works in kw.	Nature of Fuel used.	Total Cost of Constructing and Equipping Works.	Cost of Mains.	Annual Revenue per 8 C.P. Lamp	Number of High Voltage Lam used.
., 2 45 kw., c lighters	Rope, belt and direct	Non-condensing	B.I.W. and Fowler-Waring lead covd. arm'rd. conc.	11 arcs, 2,500 8 c.p.	29 arcs....	1,200....	6d.	Meter ..	Hookham and Thomson	245	Anthracite	—	—	—	200 .....
v., 2 60 kw., ., 1 240 kw.	Direct and rope	Condensing....	Fdrs. conc. v.r. in pipes, dist. paper ld. c. and arm'd	33,974 8 c.p.	—	8,974....	6d.	—	Shallenb'r, Hookham and Thomson	600	H'se scr'ings and slack	£27,598	£14,614	—	—
., 2 100 kw.,	Direct ..	Either	Callender's concentric	14,479 8 c.p.	90 arcs, 75 16 c.p.	—	5d.	Meter ..	Thomson and Hookham	625	Dross	£45,000	£13,158	6/7	About 1,500 200 v.
2 300 kw.	Rope and direct	Condensing....	Callender's solid and armoured concentric	25,388 8 c.p.	88 arcs, 13 50 c.p.	5,030....	Lighting 4½d., power 3d.	—	Shallenb'r, Hookham and Thomson	900	Coal	—	—	—	None .....
., 1 60 kw...	Direct ..	—	B.I.W. solid triple conc.....	6,500 8 c.p.	17 arcs	6,500....	6d., less 10 %	Meter ..	Thomson.....	300	Steam coal	£37,000	£15,500	—	All.....
, 2 90 kw., v., 2 250 kw.	Direct ..	Surface condensers	Rubber cables in iron pipes or conduits, and B.I.W. paper cables	32,234 8 c p., inc. motors & st. lamps	530 2-lamp standards	5,532....	5d , less ½d. within 1 mo.	—	Hookham and Shallenberger	890	Hard steam coal and scrnd. peas	£35,000	£42,800	—	None .....
, 1 200 kw , v., 3 50 kw., v., 2 650 kw.	Rope and direct	Condensing....	B.I.W. paper cbls. laid in earthenware troughs	56,000 8 c.p.	233 arcs, 290 incandescents	—	7d. and 2d., motors, 2½d., traction, 2d. and 1½d.	Demand indicator	Shallenberger, Thomson & Arcn	2,400	Bituminous coal and coke	With extensions £162,500	£32,000	4/6 priv. ltg. only	With few exceptions 200 v used
, 2 100 kw., ,A.C.; 2 600 00 kw.,D.C.	2 ropes and 9 direct	Both. Klein cooler	Rub. concen. fdrs., jute arm'rd distrs., B.I.W. for both	68,245	10 arcs, 6 incandescents	12,245 ..	6d., 3d., or 5d. all rnd. 10 % dis mot., 5d., 1d., traction, 1½d.	Brighton, &c.	Shallenberger, Thomson, Hookham and Ferranti	2,700	Slack, at 12/4	£117,589		5/–	—
, 1 150 kw., v., 3 60 kw.; 0 kw., D.C.	Ropes and direct	Condens. Klein cooler, Körting spray coolers	Arm'rd con. in grd., unarm'rd con. in pipes and conduits	54,000 8 c.p.	None	10,000 ..	7d. and 3½d.	Brighton	Thomson and Aron	1,430	Small coal and coke	—	—	6/10	About 12,000 ..
. Kapp; 1 E.A.G.	Belts and direct	Condensing, two engines	Lead covered conc. laid in ground, B.I.W.	5,512.....	30 arcs; 182 incan. 25 & 32 c.p.	623	6d. and 3½d.	Meter ..	Shallenberger and Hookham	195	Welsh steam coal and slack	£8,510		—	A few; 2·5 kw. tentatively
4 400 kw., ., 2 165 kw.,	Direct ..	Surface condensing	Arm'rd lead con.; distbrs., tri. con.; six con. for arcs	106,412....	41 incan., 310 arcs = 5,241 8 c.p.	27,527 ..	Lighting, 5d. to 2½d., pwr., 1½d. to 1⅓d.	By meter and auto. clock	Thomson, Shallenberger and Aron	3,102	Coal, Welsh pea nut	£222,944, including mains, &c.	£110,272	7/10	—
each, 1 220	Rope and direct	Eject. condens., 1 jet condenser	Fdrs., con. lead cov. B.I.W. paper in pipes	14,534 8 c.p.	—	3,564....	6d. and 3d.; power, 2½d.	Brighton	Shallenb'r, Hookham and Thomson	460	Slack, coke, gas wks. ref.	£30,000		4/9	None .....
—	Direct ..	Condensing, jet and surface	Fdrs., v.r. in pipes, B.I.W. tri. con. dist.	7 arcs, 30,732 8 c.p.	1 arc.....	2,863....	7d. and 3½d. for ltg & power	Hopkinson max. dem.	Shallenberger & Thomson	—	Slack	£68,483		6/–	Changing over
2 180 kw.,	Direct ..	Condensing....	Silvertown conc., B.I.W. and Siemens	27,247 8 c.p.*	78 arcs, 62 glow*	5,749* ..	6d. & 3d. ltg., 2½d. pr. & htg., & 2d. 4000 p.an	Brighton for lghtg purposes	Thomson, Shallenberger and Aron	1,040	Washed pea nut and nut coal	£85,718		8/–	12,000 .....
1 50 kw., 0 kw., D C	Belt	Non-condensing	Ovhd. to Carlow, lead cov. cbls. in Doulton con.	1,052 incandescents	18 arcs and 54 16 c.p.	140	7½d., with discounts	Meter ..	Thomson-Houston	145	Welsh coal	—	—	—	—
.....	Belt	—	Lead cov. paper, B.I.W.....	—	16 32 c.p. incandsnt.	—	10/– per 8 c.p. per annum	Contract	—	44	—	—	—	10/–	None .....
1 100 kw., , 1 500 kw.	Rope, belt and direct	Condensing....	Brooks, Glover's con.	12,733 8 c.p.	—	3,333	7d. and 2½d.; or 5d.	Meter ..	Shallenb'r, Thomson, Aron and Hookham	900	Welsh coal and small	—	—	—	None .....
0, 2 70, 1 A.C.; 1 55, kw., D.C	Direct ..	Non-condensing	Paper conc. and vulc. rubber	8 arcs, 14,000 8 c.p.	20 arcs, 262 32 c.p. incandes'nt	3,368....	6½d., ½d. disc. within 1 mo	—	Thomson and Hookham	615*	Sml. nuts & Hard stm.	—	—	8/8	All street lamps, 50 private
3 110 kw.	Direct ..	Condensing....	Armoured and unarmoured..	28,100 8 c.p.	243 arcs, 18 incands.	—	6d. to 3½d., 3d. for power	Brighton (approx.)	Mainly Thomson	800	Small coal	£40,360*	£39,450	—	All extensions..
1 37½ kw.	Rope ..	Independent condenser	H.P. con. vul. rub., L.P. Callender's solid	9 arcs, 5,300 8 c.p.	10 arcs, 74 incand.	—	7d. and 3½d., or 5d.	Brighton	Thomson	187½	Washed nuts	—	—	—	About 1,200....
1 100 kw.,	Rope and direct	Part condensing	L.P. arm. conc., H.P. laid solid, B I.W.	22,000 8 c.p.	40 arcs	6,300....	6d. and 3d.	Brighton	Hookham, Thomson and Westinghouse	550	Local coal	£45,000	£25,000	5/8	—
3 120 kw., w., 2 500	Direct ..	Condensing....	Callender's concentric	54,013 8 c p.	135 arcs, 8 incands.	15,700 ..	7d. and 2d.; or 6d.	Flat rate and D. I.	Thomson	1,260	Welsh coal	—	—	6/8	Throughout system
2 150 kw., 2 28 kw., arc	Direct ..	Condensing....	H.P. con. jute, ld. cov., arm'rd and in pipes; L.P. i.r. and B.I.W. paper	48,000	77 arcs 4 50 c.p.; 80 16 c p.	9,000....	Lgt. 6d. & 3d., pwr., 3d., 2d. and 1d.	Brighton	Aron, Thomson, Shallenberger & Hookham	1,700	Screened peas	£110,000		—	About 10,000 ..
1 75 kw., w., and 1	Direct ..	Condensing....	Silvertown v.r., Callender, B.I.W. and Glover	16,900 8 c p.	40 arcs	3,000....	Ltg 7d. & 3d., or 6d.; pwr. 2½d.	Brighton or fixed	Thomson and Aron	775	Welsh coal	£75,690, including trac. plt.	£20,228	7/–	None.....
3 150 kw., ., and 3 c lighters	Direct and rope	Non-condensing	Callender's solid system and B.I.W.	30,000 8 c p.	81 arcs	7,000....	7d.	Sliding scale to 5d.	Shallenberger and Thomson	900	Welsh coal	£81,000	—	8/–	200 v. throughout
2 60 kw., 3 18 k.w., 2 300 kw.	Direct ..	Condensing....	Siemens arm. con. cab. for H.P., Callender L.P.	36,241 8 c.p	75 arcs, 891 incands.	5,005....	Ltg. 7d., 6d., 5½d., 5d., 4½d. & 4d.; pw. 4d.	Discount for cash	Thomson and Shallenberger	1,112	Pea and Welsh coal	£99,652, to Mr. 31, 1900	£49,873	9/10	None .....
2 70 kw., 1 150 kw.,	Rope and direct	Fow. and Mars. are condensing, others not	Rubber in iron pipes and concentric	35,310 8 c p.	25 arcs	8,074....	Lighting 7½d., power 4d.	L. hs. 7½d 1st 2, 4d. af. others net	Shallenb'r, Hookham, Aron, Thomson and Vulcan	690	Large Welsh coal	£71,500	£16,020	6/7	3,131 8 c.p. eq. 200 v.
1 25 kw. rnatr. and tors	Direct coupled	Ejector condensers	Glover cables. distributors laid in wooden troughing	7,184 8 c.p.	445 8 c.p...	7,184....	7d. first hour, 2d. after	Brighton	Hookham.....	265	Coal, burgie & sl'ck mixed	£9,250	£4,897	Pr. 1/11, pub. ltg 12/6	—
50 kw., 2 1 250 kw. arc lgt.	Rope, belt and direct	Non-condensing	Concentric arm'rd laid in ground and B.I.W.	18 arcs, 21,000 8 c.p.	33 arcs, 66 incands.	4,000....	Lighting 6d. to 4d., power 3d.	Sliding scale	Shallnbgr., Thomson, Hookham	670	Welsh coal	—	—	—	None at present
50 kw. alt.. t arc	Blts., ropes & direct	Condensing....	Overhead Okonite, and B.I.W. paper in condts.	2,819 8 c.p.	27 arcs, 109 20 c.p.	616	7d.	No discount	Shallnbgr., Thomson, Hookham	140	Welsh coal, smll. house	£11,000	£4,000 (about)	10/–	None .....
2 100 kw., 2 350 kw	Rope and direct	Condensing....	Vulc. rubber, Callender and B.I.W. paper	42 arcs, 45,408 8 c.p.	60 arcs, 120	13,000 ..	4d. lighting,	Discounts	Thomson and	1,300	Yorkshire	£93,000		6/0	All new consu-

view" List of Electricity Works of

HIGH PRESSURE ALTERNATING C

es.	Type of Generators.	Size of Generators.	System of Driving.	Condensing or Non-condensing.	Type of Mains.	No. of Arcs and equiv. 8 c.p. Incandescents used in Private Lighting.	Number of Lamps used in Street Lighting; Arc and Incandescent.	Number of 8 C.P. Lamps added during past 12 months.	Price Charged to Private Consumers.	System of Charging.	Type of Meters Employed on Consumers' Premises.	Present actual Capacity of Works in kw.	Nature of Fuel used.
dley, 75 che	4 Johnson-Phillips, 2 Brush arc	2 50 kw., 2 45 kw., 2 55-arc lighters	Rope, belt and direct	Non-condensing	B.I.W. and Fowler-Waring lead covd. arm'rd. conc.	11 arcs, 2,500 8 c.p.	29 arcs....	1,200....	6d.	Meter ..	Hookham and Thomson	245	Anthracite
00 h.p.,	5 Edison-Swan	2 120 kw., 2 60 kw., 1 30 kw., 1 240 kw.	Direct and rope	Condensing....	Fdrs. conc. v.r. in pipes, dist. paper ld. c. and arm'd	33,974 8 c.p.	—	8,974....	6d.	—	Shallenb'r, Hookham and Thomson	600	H'se scr'ing and slack
1; 1 50 50 h.p.	5 Siemens	2 200 kw., 2 100 kw., 1 25 kw.	Direct ..	Either	Callender's concentric	14,479 8 c.p.	90 arcs, 75 16 c.p.	—	5d.	Meter ..	Thomson and Hookham	625	Dross ...
Pollitt	4 Mordey rope-driven, 2 300 kw. E.C.C. direct-driven	4 75 kw., 2 300 kw.	Rope and direct	Condensing....	Callender's solid and armoured concentric	25,388 8 c.p.	88 arcs, 13 50 c.p.	5,030....	Lighting 4½d., power 3d.	—	Shallenb'r, Hookham and Thomson	900	Coal .....
iss....	Fowler.....	2 120 kw., 1 60 kw...	Direct ..	—	B.I.W. solid triple conc.....	6,500 8 c.p.	17 arcs	6,500....	6d., less 10 %	Meter ..	Thomson.....	300	Steam coa
h.p.; 2 00 h.p.,	2 Johnson-Phillips, 2 Siemens, 3 Fynn	2 30 kw., 2 90 kw., 1 150 kw., 2 250 kw.	Direct ..	Surface condensers	Rubber cables in iron pipes or conduits, and B.I.W. paper cables	32,234 8 c.p., inc. motors & st. lamps	530 2-lamp standards	5,532....	5d, less ½d. within 1 mo.	—	Hookham and Shallenberger	890	Hard steam coal and scrnd. pea
00 h.p., anti. 2 00 h.p.,	Leeds and London, Ferranti, E.C.C., and Parsons	1 300 kw., 1 200 kw., 2 100 kw., 3 50 kw., 2 125 kw., 2 650 kw.	Rope and direct	Condensing....	B.I.W. paper cbls. laid in earthenware troughs	56,000 8 c.p.	233 arcs, 290 incandescents	—	7d. and 2d., motors, 2½d., traction, 2d. and 1⅜d.	Demand indicator	Shallenberger, Thomson & Arcn	2,400	Bituminous coal and coke
usgrave k-Har.; com.	Mordey, Ferranti, and Mather and Platt	4 200 kw., 2 100 kw., 1 50 kw., A.C.; 2 600 kw., 2 300 kw., D.C.	2 ropes and 9 direct	Both. Klein cooler	Rub. concen. fdrs., jute arm'rd distrs., B.I.W. for both	68,245	10 arcs, 6 incandescents	12,245 ..	6d., 3d., or 5d. all rnd. 10 % dis mot., 5d., 1d., traction, 1½d.	Brighton, &c.	Shallenberger, Thomson, Hookham and Ferranti	2,700	Slack, at 12/4
marine	Mordey	2 400 kw., 1 150 kw., 2 100 kw., 3 60 kw.; and 2 100 kw., D.C.	Ropes and direct	Condens. Klein cooler, Körting spray coolers	Arm'rd con. in grd., unarm'rd con. in pipes and conduits	54,000 8 c.p.	None	10,000 ..	7d. and 3½d.	Brighton	Thomson and Aron	1,430	Small coal and coke
20 h.p., n-And.; or tur 6 100	Kapp and Easton-Anderson-Goolden	2 60 kw., Kapp; 1 75 kw., E.A.G.	Belts and direct	Condensing, two engines	Lead covered conc. laid in ground, B.I.W.	5,512.....	30 arcs; 182 incan. 25 & 32 c.p.	623	6d. and 3½d.	Meter ..	Shallenberger and Hookham	195	Welsh steam coal and slack
	Siemens and Ferranti	2 88 kw., 4 400 kw., 4 210 kw., 2 165 kw., 6 52 kw.	Direct ..	Surface condensing	Arm'rd lead con.; distbrs., tri. con.; six con. for arcs	106,412....	41 incan., 310 arcs = 5,241 8 c.p.	27,527 ..	Lighting, 5d. to 2½d., pwr., 1½d. to 1½d.	By meter and auto. clock	Thomson, Shallenberger and Aron	3,102	Coal, Welsh pea nut
each, 1	Lowrie-Hall	3 80 kw. each, 1 220 kw.	Rope and direct	Eject. condens., 1 jet condenser	Fdrs., con. lead cov. B.I.W. paper in pipes	14,534 8 c.p.	—	3,564....	6d. and 3d.; power, 2½d.	Brighton	Shallenb'r, Hookham and Thomson	460	Slack, coke, gas wks. ref
.....	Parsons	—	Direct ..	Condensing, jet and surface	Fdrs., v.r. in pipes, B.I.W. tri. con. dist.	7 arcs, 30,732 8 c.p.	1 arc.....	2,863....	7d. and 3½d. for ltg & power	Hopkinson max. dem.	Shallenberger & Thomson	—	Slack ....
p. trp., 0 i.h.p., n	5 Siemens disc armature, and 1 Ferranti flywheel	2 40 kw., 2 180 kw., 2 300 kw.	Direct ..	Condensing....	Silvertown conc., B.I.W. and Siemens	27,247 8 c.p.*	78 arcs, 62 glow*	5,749* ..	6d. & 3d. ltg., 2½d. pr. & htg., & 2d. 4000 p.an	Brighton for lghtg purposes	Thomson, Shallenberger and Aron	1,040	Washed pea nut and nut coal
urbines h.p.	E.C.C. alternators at Milford	1 65 kw., 1 50 kw., A.C.; 1 30 kw., D C	Belt	Non-condensing	Ovhd. to Carlow, lead cov. cbls. in Doulton con.	1,052 incandescents	13 arcs and 54 16 c.p.	140	7½d., with discounts	Meter ..	Thomson-Houston	145	Welsh coal
te, 14	Siemens	2 22 kw.	Belt	—	Lead cov. paper, B.I.W.....	—	16 32 c.p. incandsnt.	—	10/- per 8 c.p. per annum	Contract	—	44	—
rshall; 0 h.p.,	2 Brush and 2 Ferranti alternators, 1 Parsons	2 125 kw., 1 100 kw., 1 50 kw., 1 500 kw.	Rope, belt and direct	Condensing....	Brooks, Glover's con.	12,733 8 c.p.	—	3,333	7d. and 2½d.; or 5d.	Meter ..	Shallenb'r, Thomson, Aron and Hookham	900	Welsh coal and small
0 h.p., h.p.,	Crompton	1 160, 2 80, 2 70, 1 20 kw., A.C.; 1 55, 2 28, 2 12 kw., D.C	Direct ..	Non-condensing	Paper conc. and vulc. rubber	8 arcs, 14,000 8 c.p.	20 arcs, 262 32 c.p. incandes'nt	3,368....	6½d., ½d. disc. within 1 mo	—	Thomson and Hookham	615*	Sml. nuts & Hard stm.
llans; iss	Siemens	1 33 kw., 3 110 kw. 2 220 kw.	Direct ..	Condensing....	Armoured and unarmoured..	28,100 8 c.p.	243 arcs, 18 incands.	—	6d. to 3⅜d., 3d. for power	Brighton (approx.)	Mainly Thomson	800	Small coal
ich; 1	Mordey	3 50 kw., 1 37½ kw.	Rope ..	Independent condenser	H.P. con. vul. rub., L.P. Callender's solid	9 arcs, 5,300 8 c.p.	10 arcs, 74 incand.	—	7d. and 3½d., or 5d.	Brighton	Thomson	187½	Washed nuts
0 h.p., rtical	Fowler & Co., and Fynn	1 50 kw., 1 100 kw., 2 200 kw.	Rope and direct	Part condensing	L.P. arm. conc., H.P. laid solid, B I.W.	22,000 8 c.p.	40 arcs	6,300....	6d. and 3d.	Brighton	Hookham, Thomson and Westinghouse	550	Local coal
2 800	British Thomson-Houston ..	1 75 kw., 3 120 kw., 2 250 kw., 2 500 kw.	Direct ..	Condensing....	Callender's concentric	54,013 8 c.p.	135 arcs, 8 incands.	15,700 ..	7d. and 2d.; or 6d.	Flat rate and D. I.	Thomson	1,860	Welsh coal
0 h.p., 0 h.p.,	Siemens and Ferranti; Siemens D.C. arc lighters	2 600 kw., 2 150 kw., 3 60 kw., 2 28 kw., 3 18 kw. arc	Direct ..	Condensing....	H.P. con. jute, ld. cov., arm'rd and in pipes; L.P. i.r. and B.I.W. paper	48,000	77 arcs. 4 50 c.p.; 80 16 c p.	9,000....	Lgt. 6d. & 3d., pwr., 3d., 2d. and 1d.	Brighton	Aron, Thomson, Shallenberger & Hookham	1,700	Screened peas
2 175 ntosh	Mordey, and G. E. dynamos for tramways	1 50 kw., 1 75 kw., 2 100 kw., and 1 150 kw.	Direct ..	Condensing....	Silvertown v.r., Callender, B.I.W. and Glover	16,900 8 c p.	40 arcs	3,000....	Ltg. 7d. & 3d., or 6d.; pwr. 2½d.	Brighton or fixed	Thomson and Aron	775	Welsh coal
p., 1 0 h.p.,	E.C.C., Fowler, British Thomson-Houston, Brush	2 200 kw., 3 150 kw., 1 50 kw., and 3 Brush arc lighters	Direct and rope	Non-condensing	Callender's solid system and B.I.W.	30,000 8 c.p.	81 arcs	7,000....	7d.	Sliding scale to 5d.	Shallenberger and Thomson	900	Welsh coal
0 h.p.,	Siemens	2 131 kw., 2 60 kw., 2 28 kw., 3 18 k.w., 2 10 kw., 2 300 kw.	Direct ..	Condensing....	Siemens arm. con. cab. for H.P., Callender L.P.	36,241 8 c.p	75 arcs, 891 incands.	5,005....	Ltg. 7d., 6d., 5½d., 5d., 4½d. & 4d.; pw. 4d.	Discount for cash	Thomson and Shallenberger	1,112	Pea and Welsh coal
1 200 eache; ans	E.C.C. and Fowler	1 50 kw., 2 70 kw., 1 100 kw., 1 150 kw., 1 250 kw.	Rope and direct	Fow. and Mars. are condensing, others not	Rubber in iron pipes and concentric	35,310 8 c p.	25 arcs	8,074....	Lighting 7½d., power 4d.	L. hs. 7½d 1st 2, 4d. af. others net	Shallenb'r, Hookham, Aron, Thomson and Vulcan	690	Large Welsh coal
wett-	Johnson & Phillips	2 120 kw., 1 25 kw. motor altrnatr. and accumulators	Direct coupled	Ejector condensers	Glover cables. distributors laid in wooden troughing	7,184 8 c.p.	445 8 c.p...	7,184....	7d. first hour, 2d. after	Brighton	Hookham.....	265	Coal, burgie & sl'ck mixed
0 h.p. 5 h.p., h.p.	Brush, Easton-Anderson, Thomson - Houston and Ferranti	2 75 kw., 1 50 kw., 2 100 kw., 1 250 kw. alt., 2 30 arc lgt.	Rope, belt and direct	Non-condensing	Concentric arm'rd laid in ground and B.I.W.	18 arcs, 21,000 8 c.p.	33 arcs, 66 incands.	4,000....	Lighting 6d. to 4d., power 3d.	Sliding scale	Shallnbgr., Thomson, Hookham	670	Welsh coal
, 1 95	Thomson-Houston, Johnson and Phillips	2 35 kw., 1 50 kw. alt., 2 30 light arc	Blts., ropes & direct	Condensing....	Overhead Okonite, and B.I.W. paper in condts.	2,819 8 c.p.	27 arcs, 109 20 c.p.	616	7d.	No discount	Shallnbgr., Thomson, Hookham	140	Welsh coal, smll house

1 600 h.p.													
	(26) Ealing	Urban District Council	Sub-station ..	6 Lancs., .. Coates; 3 60 h.p., Brush	11 Browett-Lindley; 2 45 h.p.		Siemens		Brush arc lighters	2 131 kw., 2 60 kw.,	Direct	Condensing	

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G CURRENT.

Present actual Capacity of Works in kw.	Nature of Fuel used.	Total Cost of Construct- ing and Equipping Works.	Cost of Mains.	Annual Revenue per 8 C.P. Lamp	Number of High Voltage Lamps used.	Frequency, Cycles per second.	Declared Pressure at Consumers' Terminals.	No. and aggregate H.P. of Motors connected.	REMARKS.	Engineer-in-Chief.	PLACE.
											PROVINCIAL.
245	Anthracite	—	—	—	200	100	100 v. and 220 v.	1 = 1 h.p.	—	E. E. Putland..	**Aberystwyth** ....(1)
600	H'se scr'ings and slack	£27,538	£14,614	—	—	80	100 v.	—	—	H. C. Caldwell	**Altrincham**.....(2)
625	Dross	£45,000	£13,158	6/7	About 1,500 200 v.	60	100 v. and 200 v.	2 = 12 h.p.....	—	Arthur J. Fuller	**Ayr**.....(3)
900	Coal	—	—	—	None	100	—	5 = 6 h.p.	90 arcs being added for street lighting	Francis Teague	**Bath** .....(4)
300	Steam coal	£37,000	£15,500	—	All.....	50	200 v.	—	—	A. J. Hedgcock	**Beckenham**.....(5)
890	Hard steam coal and scrnd. peas	£35,000	£42,800	—	None	60	100 v.	18 = 77 h.p. ..	—	W. J. Hope-Johnstone	**Bedford** .....(6)
2,400	Bituminous coal and coke	With ex- tensions £162,500	£32,000	4/6 priv. ltg. only	With few excep- tions 200 v. used	83	200 v.	14 = 85 h.p. ..	900 consumers	Robt. C. Quin..	**Blackpool** .....(7)
2,700	Slack, at 12/4	£117, 589		5/–	—	83	100 & 200 v., A.C.; 230 & 460v., D.C.; 500 v. trac.	30 motors, 160 h.p.	Power supplied to 82 cars; about 23 miles of track	Arthur A. Day	**Bolton** ‡.....(8)
1,430	Small coal and coke	—	—	6/10	About 12,000 ..	100	100 v. and 200 v.	8 A.C. = 6 h.p., 22 D.C. = 330 h.p., traction	—	E. Ll. Ingram ..	**Bournemouth** ..(9)
195	Welsh steam coal and slack	£8, 510		—	A few; 2·5 kw. tentatively	60	100 v.	—	—	Thomas Tomlinson	**Bray (Ireland)**..(10)
3,102	Coal, Welsh pea nut	£222,944, including mains, &c.	£110,272	7/10	—	93	105 v. or 210 v., 250 v., Pow. 500 v.	100 = 383 h.p.	—	H. Faraday Proctor	**Bristol** ‡ ..... (11)
460	Slack, coke, gas wks. ref.	£30, 000		4/9	None	75	100 v.	7 h.p.	—	F. L. Ramsden	**Burton-on-Trent**(12)
—	Slack	£68, 483		6/–	Changing over	90	100 v. and 200 v.	9½ b.h p.	With Barker & Ewing's max. dem. attacht.	— Harvey	**Cambridge** ....(13)
1,040	Washed pea nut and nut coal	£85, 718		8/–	12,000	40	100 v. and 200 v.	15 = 15½ h.p. ..	*March 31st, 1900.....	A. Ellis	**Cardiff**.....(14)
145	Welsh coal	—	—	—	—	—	100 v. and 200 v.	—	—	W. M. Harris (Consulting)	**Carlow**† .....(15)
44	—	—	—	10/–	None	99	—	—	—	G. H. Reed....	**Chagford** .....(16
900	Welsh coal and small	—	—	—	None	100	100 v.	2 = 12 h.p.	—	Chas. T. Linney	**Chatham** .....(17)
615*	Sml. nuts & Hard stm.	—	—	8/8	All street lamps, 50 private	100	100 v. and 200 v.	17 = 75 h.p. ..	* Not all available at once	A. H. French ..	**Chelmsford** ....(18)
800	Small coal	£40,360*	£39,450	—	All extensions..	100	100 v. and 200 v.	4 = about 17 h.p.	* Street lamps, £10,100	Hamilton Kilgour	**Cheltenham** ....(19)
187½	Washed nuts	—	—	—	About 1,200....	100	100 v. and 240 v.	—	—	J. B. McIndoe..	**Coatbridge** ....(20)
550	Local coal	£45,000	£25,000	5/8	—	87	200 v.	15 = 22 h.p. ..	—	—	**Coventry** ..... (21)
,660	Welsh coal	—	—	6/8	Throughout system	60	200 v.	9	—	T. Herbert Minshall	**Croydon** .....(22)
,700	Screened peas	£110, 000		—	About 10,000 ..	40	102 v. and 205 v.	65 = 260 h p. ..	—	T. P. Wilmshurst	**Derby** ‡ .....(23)
775	Welsh coal	£75,690, including trac. plt.	£20,228	7/–	None.....	100	100 v.	—	—	L. W. Woodman	**Dover** ‡ .....(24)
900	Welsh coal	£81,000	—	8/–	200 v. through- out	83	200 v.	20 e.h.p.	New station about to be erected and mains extd., £250,000	Mark Ruddle ..	**Dublin**.....(25)
,112	Pea and Welsh coal	£99,652, to Mr. 31, 1900	£49,873	9/10	None	40	102 v.	9	Superheaters being fitted to all boilers	J. Douglas Knight	**Ealing**.....(26)
690	Large Welsh coal	£71,500	£16,020	6/7	3,131 8 c.p. eq. 200 v.	83	100 v. and 200 v.	17 = 9 h.p.....	Will change to 2,000 v., 50 v., 200 v., dec.p. New stn. bdg., 800 kw. plt. or.	J. K. Brydges ..	**Eastbourne** ....(27)
265	Coal, bur- gie & sl'ck mixed	£9,250	£4,897	Pr. 1/11, pub. ltg. 12/6	—	50	200 v.	None	—	James Moss....	**Eccles**† .....(28)
670	Welsh coal	—	—	—	None at present	100	100 v.	10 = 22 h.p. ..	—	H. D. Munro ..	**Exeter**.....(29)
140	Welsh coal, sml. house	£11,000	£4,000 (about)	10/–	None	125	100 v.	—	—	Arthur Blake ..	**Fareham** .....(30)

Thomson-Houston, and Phillips	Johnson	2 35 kw., 1 50 kw. alt., 2 30 light arc	Blts., ropes & direct	Condensing....	Overhead Okonite, and paper in condts.	B.I.W.	2,819 8 c.p.	27 arcs, 109 20 c.p.	616	7d.	No discount	Shallnbgr., Thomson, Hookham	140	Welsh coal,

				Coates; 3 60 h.p., Brush			Brush arc lighters		
(26) Ealing	Urban District Council	Sub-station ..	6 Lancs. ..	11 Browett-Lindley; 2 450 b.h.p., Belliss	Siemens	2 131 kw., 2 60 kw., 2 28 kw., 3 18 k.w., 2 10 kw., 2 300 kw.	Direct ..	Condensing....
(27) Eastbourne ..	Eastbourne Corporat'n	Street and house transformers	2 loco., 2 econ, 2 water tube	1 250, 1 60, 1 50 h.p., Fowler; 1 200 h.p., Marshall; 1 260 h.p., Peache; 1 100 h.p., 1 350 h.p., Wilans	E.C.C. and Fowler	1 50 kw., 2 70 kw., 1 100 kw., 1 150 kw., 1 250 kw.	Rope and direct	Fow. and Mars. are condensing, others not
(28) Eccles†	Corporation	House trans. & sub-stations	Lanc.	2 200 h.p. vertical, Browett-Lindley	Johnson & Phillips	2 120 kw., 1 25 kw. motor altrnatr. and accumulators	Direct coupled	Ejector condensers
(29) Exeter	Corporation	Sub-station	5 water tube, 1,200 h.p	2 com. hori. 150 h.p., 1 do 80 h.p. 1 com. v. 200 h.p., 2 tri. ex 25 h.p., 1 v. 200 h.p., 1 v. com. 400 h.p.	Brush, Easton-Anderson, Thomson-Houston and Ferranti	2 75 kw., 1 50 kw., 2 100 kw., 1 250 kw. alt., 2 30 arc lgt.	Rope, belt and direct	Non-condensing
(30) Fareham	Urban District Council	Sub-station & house trans	2 loco., 1 econ.	1 105 h.p., 1 75 h.p., 1 40 h.p., 1 95 i.h.p., Peache	Thomson-Houston, Johnson and Phillips	2 35 kw., 1 50 kw. alt., 2 30 light arc	Blts., ropes & direct	Condensing....
(31) Halifax	Corporation	Sub-stations	4 Lancs., 2 B. & W.	1 100 i.h.p., 2 200 i.h.p., 1 600 i.h.p., 1 600 i.h.p. (3 1,000 h.p. erecting)	E.C.C.	1 50 kw., 2 100 kw., 2 200 kw., 2 350 kw., 3 750 kw. on order	Rope and direct	Condensing....
(32) Hanley	Corporation	Sub-stations	6 Lancs. ..	2 100 i.h.p., 2 200 i.h.p., 2 25 i.h.p., 1 500 i.h.p., Brush; 1 1,000 i.h.p., Ferranti	Mordey and Ferranti, and Brush arcs	2 50 kw., 2 100 kw., 2 arc 12 kw., 1 300 kw., 1 600 kw.	Rope and direct	Condensing....
(33) Harrogate	Corporation	Sub-stations	3 Lancs ..	2 250 h.p., 2 600 h.p., M'Laren; 1 600 h.p., Parsons turbine on order	3 Ferranti and 1 Siemens ..	2 125 kw., 2 300 kw.	Direct	Condensing....
(34) Hastings	Hastings Corporation	Sub-stations & house trans.	3 water tube	3 200 h.p., 1 120 h.p., Raworth; 2 300 h.p., Belliss; 1 60 h.p., Davy Paxman	Mordey and 1 Crompton....	3 100 kw., 1 50 kw., 2 200 kw., 1 35 kw	Rope and direct	Wright & Wheeler condensers Wheeler cooler
(35) Huddersfield ..	Corporation	Sub-stations	6 water tube 6 Lancs.	2 200 h.p., 1 450 h.p., 2 450 h.p., Ferranti and Brush; 2 1,250 h.p., M'Laren	Mordey, Ferranti and Siemens	1 100 kw., 1 140 kw., 1 250 kw., 2 300 kw., 2 600 kw.	Rope and direct	Condensing....
(36) Keswick†	Keswick Elec. Light Co.	House transformers	Lancs.	Engine and turbine	Kapp	2 30 kw.	Belt	—
(37) Killarney	Electric Ltg. Co.	Sub-stations	1 loco. type, Marshall	1 engine 60 h.p., 1 turbine 50 h.p., 1 water-wheel 100 h.p.	Mordey and Ferranti	1 60 kw., 1 25 kw., 1 80 kw.	Ropes ..	Condensing....
(38) Kingston-on-Thames	Corporation	Sub-stations	3 Lancs., 4 B. & W.	4 30 h.p., 1 40 h.p., 2 75 h.p., 1 150 h.p., 2 300 h.p., Belliss	Siemens	1 25 kw., 2 50 kw., 1 100 kw., 4 20 kw., 2 200 kw.	Direct ..	Surface condensing
(39) Larne.....	Larne Electric Light Works, Ltd.	Sub-stations	2 Lancs. ..	2 horiz., 100 h.p., Combe-Barbour	Mordey	2 40 kw.	Rope ..	Condensing....
(40) Leeds	Corporation	Sub-stations & house trans.	Lancs. and B. & W.	Fowler, Hick-Hargreaves, and Belliss, 3 200 h.p., 3 400 h.p., 5 500 h.p., 3 1,000 h.p.	E.C.C., Fowler, and Ferranti	3 100 kw., rope drvn., 3 200 kw. do., 5 300 kw. dir., 3 640 kw dir.	Rope and direct	Condensing....
(41) Leicester	Corporation	Sub-stations	6 B. and W., 2 Lancs.	4 horiz., Hick-Hargreaves, 600 h.p. each	Ganz inductor alternators ..	4 350 kw.	Direct	Jet condenser on each engine
(42) Limavady	J. E. & E. J. S. Ritter	Sub-stations	—	Turbines, 1 220 h.p., 1 110 h.p., 1 60 h.p., 1 40 h.p., 1 12 h.p.	Siemens	460 kw.	Belt	—
(43) Lynton and Lynmouth	Electric Lighting Co.	Sub-stations	1 loco.	Giant turbines, 150 h.p. and 100 h.p., 1 engine, 40 h.p.	Mordey and Lowrie Hall....	2 38½ kw., 1 70 kw.	Direct and belt	Non-condensing
(44) Macroom (Cork)	L. H. Shaw Co.....	—	—	Water-wheel and turbine, 60 h.p. each	Mordey	2 25 kw.	Ropes ..	—
(45) Monmouth	Town Council.....	Sub-stations	2 Cornish..	2 Ransomes com. vert., 35 h.p; 3 Gilkes turbines	2 Siemens	2 21 kw.	Belt and direct	Non-condensing
(46) Morley	Corporation	Sub-stations	2 Lancs. ..	2 200 h.p., Pollitt & Wigzell; 1 70 h.p., Peache	E.C.C.	2 125 kw., 1 20 kw., 1 35 kw. exciter	Direct ..	Non-condensing
(47) Newcastle-on-Tyne‡	Newcastle and District Electric Lighting Co.	House transformers	Lancs.	Parsons turbines	Parsons turbo-alternators ..	75 to 500 kw.	Direct ..	Both.....
(48) Newcastle-on-Tyne	Newcastle Electric Lighting Co.	Sub-stations & house trans., 3 wire dist.	Lancs.	Robey horiz., 2 500 h.p.; Belliss vert. com., 1,600 h.p.	Mordey and Holmes.....	—	Rope and direct	Condensing....
(49) Newport	Corporation	Street and house trans.	7 Lancs. ..	4 com. 150 h.p., 1 com. 120 h.p., 2 500 h.p. horiz., 1 200 h.p. vert.	Fowler and Hall.....	4 75 kw., 1 50 kw., 2 300 kw., 1 100 kw.	Ropes and direct	Condensing....
(50) Paisley	Town Council.....	Sub-station, 2 wire dist.	6 B. & W..	1 1,000 h.p. hor. com., Adamson; 1 600 h.p., 1 250 h.p. vert. com., Ferranti	Ferranti ironclad, Ferranti copper	1 600 kw. ironclad, 1 350 kw., 1 150 kw. copper	Direct ..	Jet condensers
(51) Plymouth‡	Town Council.....	Sub-stations, 3 wire dist	7 Lancs. ..	2 150 h.p., 2 700 h.p., Belliss; 2 300 h.p., Ferranti	3 Westinghouse, 5 Ferranti..	2 100 kw., 1 500 kw., D.C.; 2 100 kw., 1 500 k.w., A.C.	Direct coupled	Sea water, ejector condenser
(52) Portsmouth ..	Corporation	Street transformers	9 Lancs. ..	3 400 i.h.p., 1 Parsons turbo set 250 h.p., 2 1,000 h.p.	Ferranti, Parsons and Richardson	3 212 kw., 1 150 kw., 2 600 kw.	Direct ..	Condensing....
(53) Prescot District‡	British Insulated Wire Co., Ltd.	Sub-stations	4 Lancs. ..	2 100 i.h.p., 2 250 i.h.p., 1 600 i.h.p.	Ferranti, Mordey and Johnson and Phillips A.C., Dick Kerr D.C.	2 54 kw., 2 120 kw., A.C.; 1 373 kw., D.C.	Ropes and direct	Surface condensing
(54) Reading	Reading Elec. Supply Co., Ltd.	Sub-stations & low pressure D.C.	4 Lancs, 1 B. & W.	3 200 i.h.p. horiz., com. cond.; 3 350 i.h.p., Belliss	Hall altrnatrs., E.C.C. dynamos	125 kw., 200 kw. ..	Direct ..	Condensing....
(55) Redditch	Urban District Council	Sub-stations	Dowson gas producers	2 150 b.h.p., 1 50 b.h.p., Premier tandem gas engines	Johnson-Phillips	2 100 kw., 1 35 kw...	Link belts	—
(56) Rugby	Rugby School Elec. Ltg. Co.	House transformers	Dowson gas producers	Gas engines, 1 80 h.p., 1 65 h.p.	Brush, Nalder and Harrison	1 50 kw., 1 35 kw. ..	Belts....	—
(57) Salford	Corporation	Sub-statn. and house trans., & bat. sub-sta.	12 Lancs ..	3 250 h.p., Browett-Lindley; 1 250 h.p., Mather-Platt	Mather and Platt	4 120 kw.....	Ropes and direct	Condensing and non-condensing
(58) Scarborough ..	Scarborough Electric Supply Co., Ltd.	Sub-station and house transformers	4 Lancs. ..	Parsons turbines, 4 150 kw, 1 75 kw.	Parsons	4 150 kw., 1 75 kw.	Direct ..	Jet and surface
(59) Sheffield	Corporation	Sub-stations	Water tube & marine	Compound and triple expansion and Parsons turbine	Ferranti, Brush and Parsons	1 125 kw., 2 300 kw., 1 500 kw., 1 600 kw., 1 1,100 kw.	Direct ..	Condensing....
(60) Southport‡	Corporation	Sub-stations	9 Lancs. ..	2 250 h.p., 1 500 h.p., 1 1,000 h.p., Musgrave; 2 330 b.h.p, Belliss	Ferranti and Bruce Peebles	2 125 kw., 1 300 kw., 1 600 kw., A.C.; 2 200 kw., D.C.	Direct ..	Condensing....
(61) South Shields..	Corporation	Sub-stations	Marine....	Triple expansion, 2 200 h.p., 2 400 h.p., 2 1,000 h.p.	Ferranti, Siemens, Brown Boveri	2 100 kw., 2 200 kw., 2 500 kw.	Direct ..	Condensing....
(62) Taunton	Corporation	Sub-stats. and house trans.	3 B. & W., 1 Paxman	2 300 h.p., 1 200 h.p., Belliss; 2 135 h.p., Willans; 1 50 h.p., Chandler	Thomson-Houston	2 150 kw., 2 75 kw., 1 33 kw., 1 33 kw. D.C.	Direct coupled	Jet condensers
(63) Torquay	Corporation	Street trans. & sub-stations	B. & W. ..	3 250 h.p., Willans	Fynn inductor alternators ..	125 kw. each	Direct ..	Condensing....
(64) Tunbridge Wells	Corporation	Sub-stations	5 Wr. tb. with s. htrs., 2 Lancs.	Willans and Ferranti	Johnson and Phillips and Ferranti	1 500 kw., 1 400 kw., 3 80 kw., 1 40 kw.	Direct ..	Condensing....
(65) Wakefield	Corporation	Sub-stations	2 Lancs. ..	3 180 b.h.p., Fowler; 1 50 b.h.p., Belliss	Fowler.....	3 112 kw., 1 28 kw.	Direct ..	Jet condensing
(66) Wallasey	Urban District Council	Sub-station & house trans.	3 Lancs., 1 water tube	Compound vertical, 2 125 h.p., 1 300 h.p., 2 500 h.p., Browett-Lindley and Ferranti	Ferranti	2 75 kw., 1 200 kw., 2 300 kw.	Direct ..	Condensing....
(67) Watford	Urban District Council	Sub-station & street trans.	3 B. & W...	2 250 h.p., 1 50 h.p., Universal; 1 500 h.p., Ferranti	Mordey inductor alternators and Ferranti	1 300 kw., 2 150 kw., 1 30 kw.	Direct coupled	Non-condensing
(68) West Ham	Corporation	Sub-stations & trans. boxes	4 Lancs. & 3 B. & W.	1 175 h.p., 3 350 h.p., 2 2,000 h.p., Ferranti	Ferranti	1 100 kw., 3 200 kw., 2 1,200 kw.	Direct ..	Condensing....
(69) Wimbledon....	Urban District Council	Sub-stations	4 B. & W ..	3 200 i.h.p., 1 560 i.h.p., Willans	Crompton-Brunton	3 120 kw., 1 350 kw.	Direct ..	Non-condensing, at present
(70) Woking.....	The Woking Elec. Supply Co., Ltd.	Sub-statn. and street trans.	2 Hornsby w t., 3 Renshaw	1 120 h.p., Belliss; 1 120 h.p., Parsons; 1 240 h.p., Allen	Parsons, Brush and E.C.C...	2 75 kw., 1 150 kw.	Direct ..	Surface condensing
(71) Worcester	Corporation	Sub-stations & house trans.	Water tube boilers	2 54 h.p., 1 48 h.p., 1 36 h.p., Vic. turbines; 1 700 h.p., Ferranti; 3 286 h.p., Brush; 1 120 h.p., Belliss	Mordey and Ferranti	4 125 kw., 1 400 kw.	Ropes and direct	Condensing....
(72) Yarmouth	Corporation	Sub-stations	4 B. & W.	2 300 h.p., 3 150 h.p., 2 60 h.p., Willans; 1 300 h.p., Peache	Crompton	3 150 kw., 3 75 kw., 1 15 kw., 4 15 kw. (arc lighters)	Direct and rope	Surface condensers
LONDON.								
(73) Blackheath and Greenwich	Blackheath and Greenwich District Electric Light Co., Ltd.	Two-phase A.C. & D.C.	3 B. & W...	2 Belliss; 2 Clench	Electric Construction Co. and Johnson-Phillips	125 kw., and 250 kw.	Direct ..	Preparing for condensing
(74) City‡	City of London Electric Lighting Co.	Sub-stations & direct current	B. & W. and marine	Brush, Willans, Ferranti, Allis, Musgrave, Sissons, Browett-Lindley, Chandler	Mordey, Ferranti, British Thomson-Houston, Westinghouse	400 kw. to 1,800 kw.	Direct ..	Condensing....
(75) Hammersmith	Borough Council ...	Sub-stations	6 water tube	3 200 h.p., McLaren; 1 50 h.p.	5 Ferranti, copper			

..C.C.,	Fowler,	British	2 200 kw., 3 150 kw.,	Direct	Non-condensing	Callender's solid system and	30,000 8 c.p.	81 arcs	7,000....	7d.

140	Welsh coal, smll house	£11,000	£4,000 (about)	10/–	None	125	100 v.	—	—	Arthur Blake ..	**Fareham** .....(30)							
		D.I.W.						scale to 5d.	Thomson						out			
..	Condensing....	Siemens arm. con. cab. for H.P., Callender L.P.	36,241 8 c.p	75 arcs, 891 incands.	5,005....	Ltg. 7d., 6d., 5½d., 5d., 4½d. & 4d.; pw. 4d.	Discount for cash	Thomson and Shallenberger	1,112	Pea and Welsh coal	£99,652, to Mr. 31, 1900	£49,873	9/10	None	40	102 v.		
d	Fow. and Mars. are condensing, others not	Rubber in iron pipes and concentric	35,310 8 c p.	25 arcs	8,074....	Lighting 7½d., power 4d.	L. hs. 7½d lst 2, 4d. af. others net	Shallenb'r, Hookham, Aron, Thomson and Vulcan	690	Large Welsh coal	£71,500	£16,020	6/7	3,131 8 c.p. eq. 200 v.	83	100 v. 200 v		
ed	Ejector condensers	Glover cables.distributors laid in wooden troughing	7,184 8 c.p.	445 8 c.p...	7,184....	7d. first hour, 2d. after	Brighton	Hookham.....	265	Coal, burgie & sl'ck mixed	£9,250	£4,897	Pr. 1/11, pub. ltg. 12/6	—	50	200 v.		
lt i-	Non-condensing	Concentric arm'rd laid in ground and B.I.W.	18 arcs, 21,000 8 c.p.	33 arcs, 66 incands.	4,000....	Lighting 6d. to 4d., power 3d.	Sliding scale	Shallnbgr., Thomson, Hookham	670	Welsh coal	—	—	—	None at present	100	100 v.		
es ct	Condensing....	Overhead Okonite, and B.I.W. paper in condts.	2,819 8 c.p.	27 arcs, 109 20 c.p.	616	7d.	No discount	Shallnbgr., Thomson, Hookham	140	Welsh coal, smll. house	£11,000	£4,000 (about)	10/–	None	125	100 v.		
d	Condensing....	Vulc. rubber, Callender and B.I.W. paper	42 arcs, 45,403 8 c.p.	60 arcs, 120 incands.	13,000 ..	4d. lighting. 2½d. power	Discounts	Thomson and Hookham	1,300	Yorkshire coal	£93,000		6/9	All new consumers	80	230 v.		
d	Condensing....	Glover, B.I.W., & Callender	39,487 8 c.p.	72 arcs, 130 incands.	3,861....	Ltg. 6d. & 3d., power 3d. & 1d.	Maximum demand	Shallenbr., Hookham, Thomson & Aron	1,224	Slack	£73,320	£25,000	5/5	1,500.....	100	100 v. 200 v		
	Condensing....	B.I.W. concentric & Siemens	15 arcs, 29,757 8 c.p.	57 arcs, 50 32 c.p.	9,806....	Ltg. 6d., 4d., 2d., power 6d. and 2d.	Maximum demand system	Thomson, Hookham and Aron	850	Small steam coal (nuts)	£35,000	£13,600	Abt. 6/–	—	50	100 v. a few 2		
d	Wright & Wheeler condensers, Wheeler cooler	V.R. in pipes, lead covered diatrine in troughs	22,489 8 c.p.	53 arcs	4,670....	1½d. unit, 10/- 8 c.p. lamp. ann., or 6d. unit	—	Shallenb'r, Hookham, Thomson and Aron	785	Small Welsh	About £100,000	—	9/–	—	100	200 v.		
d	Condensing....	B.I.W. paper, bitumen and rubber	85,653 8 c.p.	36 arcs, 54 incands.	15,475 ..	Lighting 4½d., power 2½d. and 1d.	Discounts	Shallenberger, Thomson and Hookham	2,290	Slack	£75,000	£65,000	5/–	—	100	100 v. 200 v		
..	—	Rubber and overhead	—	—	—	—	—	Thomson	—	—	—	—	—	—	—	—		
..	Condensing....	H.P. con. armrd. and v. rub.	3,000 8 c p	5 arcs, 36 incands.	200	6d., and by contract	—	Hookham.....	165	Slack	—	—	8/–	None	100	100 v.		
..	Surface condensing	Concentric steel-armoured cables	18 arcs, 18,000 8 c.p.	41 arcs, 27 25 c.p.	3,520....	Ltg. 6d. and 4d., power 3d	Brighton	Thomson, Shallenb'r, Hookham and Aron	650	Small coal, lrg. Welsh	£33,549	£24,074	9/–	None	77	105 v.		
..	Condensing....	Armoured concentric	2,000 8 c.p.	14 arcs, 120 incands.	—	1¾d. to 8d., generally cont.	—	Shallenberger	80	Coal	£11,000	—	—	None	100	100 v.		
d	Condensing....	Vulc. rubber in c.i. pipes, and B.I.W, paper concentric	125,982 8 c.p.	1 arc.....	24,659 ..	4¾d. to 5d.	Sliding scale	Shallenberger and Thomson	4,320	Local coal..	—	—	7/2	—	83	100 v. 200 v		
	Jet condenser on each engine	Part in pipes and condts., part armd. and B.I W.	197 arcs, 61,554 8 c.p.	None.....	21,528 ..	Lighting 4d. power 2d.	No discount	Aron and Hookham	1,400	Coke.....	—	—	6/–	About 6,000....	50	100 v. 200 v		
..	—	Overhead.....	About 1,000 8 c.p.	None.....	50	10s per an. per 8 c.p. lamp	Contract	—	240	—	About £7,000	—	10/–	—	100	220 v.		
lt	Non-condensing	Callender direct, Glover dia in pipes	—	60 incandescents, 1 arc	290	£1 p.a. per 16 c.p., or 5d. & 8d.	Meter ..	Hookham.....	147	Welsh coal	—	—	—	—	83 and 100	100 v. 84 v.		
..	—	—	—	70 32 c.p., 24 50 c.p.	—	4½d.	Meter ..	Westinghouse ..	50	—	—	—	—	All.....	—	230 v.		
d	Non-condensing	Arm. fdrs., dists. in earthenware pipes	1 arc, 1,367 8 c p.	40 8 c.p. ..	—	6d.; public ltg. £3 12s. per ann.	Meter ..	Shallenberger....	42	Frst.of Dean steam coal	—	—	6/7½	None	60	102 v.		
..	Non-condensing	Callender, armd. in Doulton casing	6,540 8 c.p.	16 arcs, 33 incand.	—	5½d. with disc. up to 25 %	Meter ..	Thomson and Hookham	140	Slack	£22,000	About £5,000	—	All.....	60	200 v.		
..	Both.....	Vulcanised rubber.....	80 arcs 54,458 8 c.p	10 arcs....	5,600....	6d., with dis. up to 35 % *	Meter and M.D.	Thomson and Hookham	1,600 A.C., 800 D.C.	Small steam	£69,971	£37,006	About 6/6	None	80	100 v. 480 & v. D.C		
d	Condensing....	V.R. in iron pipes and Callender solid	64,000 8 c.p.	14 arcs	11,000 ..	4½d.	Discount	Thomson	2,370	Small steam	—	—	—	—	100	100 v. or and 2		
nd	Condensing....	Siemens v.r., Glover diatrine	29,711 8 c.p.	76 arcs	6,566....	Ltg. 6d. to 4d., power. 2d. to 1½d.	Sliding scale	Shallenberger, Thomson and Aron	1,050	Abercarn small coal	£64,555	£24,247	5/8	—	87·5	200 v 100 v		
.	Jet condensers	H.P. vul. bit., L.P. ld arm'd all con.	24,603 8 c p.	64 arcs	6,803....	Ltg 6d. and 2d. or 5d., power 2½d.	Brighton	Thomson & Aron	1,100	Lanarkshire dross	£95,000	£21,000	—	All, except in three cases	50	200 v.		
ed	Sea water, ejector condenser	Ld. cov. paper, con. and twin, armd. and in ducts.	34 arcs, 15,000 8 c.p.	74 arcs....	3,000....	4½d.	No discts. or scale	Shallenberger and Aron	1,200	Welsh steam coal	£92,900	£16,000	—	3,000.....	50	100 v. 200 v		
.	Condensing....	Con., in conduits, and B.I.W. solid	24 arcs, 71,000 8 c.p.	264 arcs, 470 32 c.p., & 16 16 c.p.	—	4½d. lighting, 2½d. power	—	Shallenb'r, Thomson & Hookham	1,986	Small bituminous	£140,000		7/6	None	50	100 v.		
nd	Surface condensing	B.I.W. lead cov., armd. and solid	2 arcs, 6,200 incands.	23 arcs, 218 incand.	1,100....	Ltg. 5d. & 3d., power 1d.	Sliding scale	Thomson and Shallenberger	348 A.C. 378 D.C.	Steam coal	£33,000		5/–	None	100	100 v.		
.	Condensing....	A.C. conc. arm'rd, single distrs.	31,000 8 c.p.	—	6,000....	Ltg. 6d. to 4d., power. 3d. to 1½d.	Discounts & time sw.	Hookham, Thomson and Westinghouse	975	Welsh steam coal	£55,000	£30,000	5/6	25,000	67	100 v. 200 v		
ts	—	Lead cov. paper, conc. in ground (H.P. armd.)	4 arcs, 7,320 8 c.p.	290 32 c.p.	2,820....	5½d., 5d. 5 p.m. till 10 p.m., 2d aft., 2d. pwr.	—	Hookham & Aron	235	Anthracite	£18,911*		—	—	66	200 v.		
.	—	Concentric, lead covered....	2 arcs, 4,000 8 c.p.	—	—	5d. and 4d., +fixed charge	Meter ..	Shallenberger, Hookham & Aron	85	Coal and coke	£4,950		6/–	None	100	100 v.		
nd	Condensing and non-condensing	Paper (B.I.W.) and fibrous, arm'rd and drawn in	59,000	3 arcs	11,000 ..	Ltg. 6d. & 2d., pwr. 3½d. & 1d.	Sliding scale	Shallenberger, Thomson and Hookham	480, 4 500 kw hr. batrs.	Gas coke ..	£150,000	£37,000	—	—	75	200 v., and 4		
.	Jet and surface	H.P. Silvertn. in c.i. pipes, L.P., B.I.W. con.	33,343 8 c.p.	—	6,172....	6½d. to 5½d., ovr. £75, 7d. & 3d., pwr. 2½d.	Discounts	Hookham, Thomson and Shallenberger	675	Steam coal	£28,387	£24,072	4/8	609	80	100 v. 200 v		
.	Condensing....	B.I.W. paper cables and bitumen conduit	123,496 8 c.p.	—	23,926 ..	Lighting 4d., power 2d.	Uniform charge	Thomson & Aron	2,925	Hard slack	£390,000		4/7	35,000 8 c.p. ..	100	100 v 200 v		
.	Condensing....	Paper (B.I.W.) and jute, lead cov., arm'd conc., D.C. Callender solid	52,243	43 arcs, 15 amp.	9,865....	6d., 4d., & 2d. for lighting 4d. & 2d. pwr.	Brighton	Shallenberger, Thomson, Hookham & Aron	1,150 A.C., 400 D.C.	Slack	£49,771	£50,365	4/11	All outlying districts	50	100 v. 210 v		
.	Condensing....	Rub. conc., and B.I.W. paper in c.i. pipes	30,983 8 c.p.	87 arcs and 300 incandescent	9,844....	Ltg. 7d. & 2d., power 2d.	Brighton	Thomson and Hookham	1,600	Unscreened coal	£100,000	£30,000	6/1	—	50	110 v. 220 v		
d	Jet condensers	Armoured concentric B.I.W cables	20,020 8 c.p.	72 arcs, 202 16 c.p.	6,025....	6d. to 3d.	Brighton	Thomson	450	Welsh coal	—	—	—	Extensions, 3,000	60	102½ v 205 v		
.	Condensing....	B.I.W. concentric solid, arm'rd and in ducts	12,026 8 c.p., 1 arc	52 arcs, 110 incands.	2,070....	7d. first hour, 3d. after	Wright's	Aron, Thomson and Hookham	375	Coal	£24,969	£5,589	—	All.....	50	200 v.		
.	Condensing....	Armoured concentric cables	36,000 8 c.p.	70 arcs, 300 incands.	9,000 ..	Ltg. 6d. & 3d., power 3d.	Demand system	Aron, Westnghse., Hookham and Thomson	1,180	Welsh coal, 36/6 ton	£56,000	£14,000	5/2	All.....	67·5	220 v.		
.	Jet condensing	Arm'rd triple conc., and 3 core B.I.W.	16,300	16 arcs	2,300....	4½d., less 2½ %	Flat rate	Thomson	390	Smudge coal	£32,000	£8,000	5/7	All.....	60	200 v.		
.	Condensing....	B.I.W. armoured	14,711 8 c.p.	19 arcs	5,398....	6d. to 4d.; free wg. 7d. to 5d.	Sliding scale	Westinghouse and Hookham	650	Coke.....	£34,473 (31/3/'00)	£8,670	—	None	50	100 v.		
d	Non-condensing	Henley's armoured concentric	7,000 8 c.p.	Equivalt. of 2,000 8 c.p.	700	8d. and 3d.	Wright's mx. dmd.	Hookham & Aron	630	Nottingham steam coal	—	—	—	All.....	50	200 v.		
.	Condensing....	B.I.W. con. ld. cov. arm. and in pipes	34,243 8 c.p.	88 enc. arcs, 56 8 c p.	12,230 ..	Ltg. 7d. & 2d., pwr. 5d. & 1d.	Wright's	Thomson	3,100	Small coal & nuts	£47,247	£29,242	—	—	50	100 v. 200 v		
.	Non-condensing, at present	Paper conc. lead covd., arm'd and unarm'd	22,970 8 c.p.	903 incand = 4,108 8 c.p.	12,502 ..	7d 1½ hours, 2d. after	Maximum demand	Shallenberger and Electrical Co.	710	Welsh coal	About £50,000	About £25,000	—	All.....	50	220 v.		
.	Surface condensing	Vulc. rubber and Callender ld. cov. and arm'rd conc.	5 arcs, 11,660 8 c.p.	123 incands. 25 c.p.	1,700....	8d. first 20 unt. 7d. after	Disct. on quantity	Shallenberger, Thomson and Hookham	300	Welsh coal	—	—	—	35	100	100 v. 200 v		
nd	Condensing....	Brooks, B.I.W. and Callender	28 arcs, 34,494 8 c.p.	57 arcs, 15 incands.	3,500 (approx.)	6½d. and 3d.	Brighton	Hookham and Thomson	900	Thr. & thr. Welsh	£74,000 (approx.)	—	3/11½	About 2,500 of 200 v.	100	100 v. 200 v		
pe	Surface condensers	Concentric, B.I.W. paper ..	24,569 8 c.p.	77 arcs	5,067....	Ltg. 6d. & 4d., power 3½d.	—	Shallenbr., Thomson & Hookham	735	Welsh coal	—	—	6/6	None	83·5	100 v.		
.	Preparing for condensing	B.I.W.....	64 arcs, 14,624 incs	None	7,919....	6d., with discounts	Flat rate	Westinghouse and Hookham	750	Welsh	—	—	—	—	—	200 v.		
.	Condensing....	Concentric B.I.W. cables, etc.	510,000 8 c.p.	508 arcs, Markets 41	80,000 ..	8d. to 2d.....	Sliding scale	Thomson and Aron	—	Small and large Welsh	£712,887 (1899)	£488,747 (1899)	—	—	—	204 v. and D.C.		

	(74) City		City of London Electric Lighting Co.	Sub-stations & direct current	B. & W. and marine	Brush, Willans, Ferranti, Allis, Musgrave, Sissons, Browett-Lindley, Chandler	Mordey, Ferranti, British Thomson-Houston, Westinghouse	400 kw. to 1,800 kw.	Direct ..	Condensing...				
	(75) Hammersmith		Borough Council ..	Sub-stations	6 water tube	2,200 h.p. Mel arcs: 1 60 h.p.								
p., 1 h.p.,	E.C.C., Fowler, British Thomson-Houston, Brush	2 200 kw., 3 150 kw., 1 50 kw., and 3 Brush arc lighters	Direct and rope	Non-condensing	Callender's solid system and B.I.W.	30,000 8 c.p.	81 arcs	7,000....	7d.	Sliding scale to 5d.	Thomson			
h.p.,	Siemens	2 131 kw., 2 60 kw., 2 28 kw., 3 18 k.w., 2 10 kw., 2 300 kw.	Direct ..	Condensing....	Siemens arm. con. cab. for H.P., Callender L.P.	36,241 8 c.p	75 arcs, 891 incands.	5,005....	Ltg. 7d., 6d., 5½d., 5d., 4½d. & 4d.; pw. 4d.	Discount for cash	Thomson and Shallenberger	1,112	Pea and Welsh coal	
1 200 uche; ans	E.C.C. and Fowler	1 50 kw., 2 70 kw., 1 100 kw., 1 150 kw., 1 250 kw.	Rope and direct	Fow. and Mars. are condensing, others not	Rubber in iron pipes and concentric	35,310 8 c p.	25 arcs	8,074....	Lighting 7½d., power 4d.	L. hs. 7½d 1st 2, 4d. af. others net	Shallenb'r, Hookham, Aron, Thomson and Vulcan	690	Large Welsh coal	
wett-	Johnson & Phillips	2 120 kw., 1 25 kw. motor altrnatr. and accumulators	Direct coupled	Ejector condensers	Glover cables, distributors laid in wooden troughing	7,184 8 c.p.	445 8 c.p...	7,184....	7d. first hour, 2d. after	Brighton	Hookham.....	265	Coal, burgie & sl'ck mixed	
h.p. h.p., h.p.	Brush, Easton-Anderson, Thomson - Houston and Ferranti	2 75 kw., 1 50 kw., 2 100 kw., 1 250 kw. alt., 2 30 arc lgt.	Rope, belt and direct	Non-condensing	Concentric arm'rd laid in ground and B.I.W.	18 arcs, 21,000 8 c.p.	33 arcs, 66 incands.	4,000....	Lighting 6d. to 4d., power 3d.	Sliding scale	Shallnbgr., Thomson, Hookham	670	Welsh coal	
1 95	Thomson-Houston, Johnson and Phillips	2 35 kw., 1 50 kw. alt., 2 30 light arc	Blts., ropes & direct	Condensing....	Overhead Okonite, and B.I.W. paper in condts.	2,819 8 c.p.	27 arcs, 109 20 c.p.	616	7d.	No discount	Shallnbgr., Thomson, Hookham	140	Welsh coal, smll. house	
600 h.p.	E.C.C.	1 50 kw., 2 100 kw., 2 200 kw., 2 350 kw., 3 750 kw. on order	Rope and direct	Condensing....	Vulc. rubber, Callender and B.I.W. paper	42 arcs, 45,403 8 c.p.	60 arcs, 120 incands.	13,000 ..	4d. lighting, 2½d. power	Discounts	Thomson and Hookham	1,300	Yorkshire coal	
h p., h.p.,	Mordey and Ferranti, and Brush arcs	2 50 kw., 2 100 kw., 2 arc 12 kw., 1 300 kw., 1 600 kw.	Rope and direct	Condensing....	Glover, B.I.W., & Callender	39,487 8 c.p.	72 arcs, 130 incands.	3,861....	Ltg. 6d. & 3d., power 3d. & 1d.	Maximum demand	Shallenbr., Hookham, Thomson & Aron	1,224	Slack	
ren; e on	3 Ferranti and 1 Siemens ..	2 125 kw., 2 300 kw.	Direct	Condensing....	B.I.W. concentric & Siemens	15 arcs, 29,757 8 c.p.	57 arcs, 50 32 c.p.	9,806....	Ltg. 6d., 4d., 2d., power 6d. and 2d.	Maximum demand system	Thomson, Hookham and Aron	850	Small steam coal (nuts)	
rth; h.p.,	Mordey and 1 Crompton....	3 100 kw., 1 50 kw., 2 200 kw., 1 35 kw	Rope and direct	Wright & Wheeler condensers, Wheeler cooler	V.R. in pipes, lead covered diatrine in troughs	22,489 8 c.p.	53 arcs	4,670....	1½d. unit, 10/- 8 c.p. lamp. ann, or 6d. unit	—	Shallenb'r, Hookham, Thomson and Aron	785	Small Welsh	
h.p., h.p,	Mordey, Ferranti and Siemens	1 100 kw., 1 140 kw., 1 25. kw., 2 300 kw., 2 600 kw.	Rope and direct	Condensing....	B.I.W. paper, bitumen and rubber	85,653 8 c.p.	36 arcs, 54 incands.	15,475 ..	Lighting 4½d., power 2½d. and 1d.	Discounts	Shallenberger, Thomson and Hookham	2,290	Slack	
.....	Kapp	2 30 kw.	Belt	—	Rubber and overhead	—	—	—	—	—	Thomson	—	—	
h.p.,	Mordey and Ferranti	1 60 kw., 1 25 kw., 1 80 kw.	Ropes ..	Condensing....	H.P. con. armrd. and v. rub.	3,000 8 c p	5 arcs, 36 incands.	200	6d., and by contract	—	Hookham.....	165	Slack	
h p, ss	Siemens	1 25 kw., 2 50 kw., 1 100 kw., 4 20 kw., 2 200 kw.	Direct ..	Surface condensing	Concentric steel-armoured cables	18 arcs, 18,000 8 c.p.	41 arcs, 27 25 c.p.	3,520....	Ltg. 6d. and 4d., power 3d	Brighton	Thomson, Shallenb'r, Hookham and Aron	650	Small coal, lrg. Welsh	
bour	Mordey	2 40 kw.	Rope ..	Condensing....	Armoured concentric	2,000 8 c.p.	14 arcs, 120 incands.	—	1¾d. to 8d., generally cont.	—	Shallenberger	80	Coal	
and h.p.,	E.C.C., Fowler, and Ferranti	3 100 kw., rope drvn., 3 200 kw. do., 5 300 kw. dir., 3 640 kw dir.	Rope and direct	Condensing....	Vulc. rubber in c.i. pipes, and B.I.W, paper concentric	125,982 8 c.p.	1 arc.....	24,659 ..	4¾d. to 5d.	Sliding scale	Shallenberger and Thomson	4,320	Local coal..	
600	Ganz inductor alternators ..	4 350 kw.	Direct	Jet condenser on each engine	Part in pipes and condts., part armd. and B.I W.	197 arcs, 61,554 8 c.p.	None.....	21,528 ..	Lighting 4d., power 2d.	No discount	Aron and Hookham	1,400	Coke.....	
h p., p.	Siemens	460 kw.	Belt	—	Overhead.....	About 1,000 8 c.p.	None.....	50	10s per an. per 8 c.p. lamp	Contract	—	240	—	
100	Mordey and Lowrie Hall....	2 38½ kw., 1 70 kw.	Direct and belt	Non-condensing	Callender direct, Glover dia in pipes	—	60 incandescents, 1 arc	290	£1 p.a. per 16 c.p., or 5d. & 8d.	Meter ..	Hookham.....	147	Welsh coal	
h.p.	Mordey	2 25 kw.	Ropes ..	—	——	—	70 32 c.p., 24 50 c.p.	—	4½d.	Meter ..	Westinghouse ..	50	—	
h.p ;	2 Siemens	2 21 kw.	Belt and direct	Non-condensing	Arm. fdrs., dists. in earthenware pipes	1 arc, 1,867 8 c p.	40 8 c.p. ..	—	6d.; public ltg. £3 12s. per ann.	Meter ..	Shallenberger....	42	Frst. of Dean steam coal	
ll; 1	E.C.C.	2 125 kw., 1 20 kw., 1 35 kw. exciter	Direct ..	Non-condensing	Callender, armd. in Doulton casing	6,540 8 c.p.	16 arcs, 33 incand.	—	5½d. with disc. up to 25 %	Meter ..	Thomson and Hookham	140	Slack	
.....	Parsons turbo-alternators ..	75 to 500 kw.	Direct ..	Both.....	Vulcanised rubber.....	80 arcs 54,458 8 c.p	10 arcs....	5,600....	6d., with dis. up to 35 % *	Meter and M.D.	Thomson and Hookham	1,600 A.C., 800 D.C.	Small steam	
elliss	Mordey and Holmes.....	—	Rope and direct	Condensing....	V.R. in iron pipes and Callender solid	64,000 8 c.p.	14 arcs	11,000 ..	4½d.	Discount	Thomson	2,370	Small steam	
h.p., vert.	Fowler and Hall.....	4 75 kw., 1 50 kw., 2 360 kw., 1 100 kw.	Ropes and direct	Condensing....	Siemens v.r., Glover diatrine	29,711 8 c.p.	76 arcs	6,566....	Ltg. 6d. to 4d., power. 2d. to 1½d.	Sliding scale	Shallenberger, Thomson and Aron	1,050	Abercarn small coal	
nson; com.,	Ferranti ironclad, Ferranti copper	1 600 kw. ironclad, 1 350 kw., 1 150 kw. copper	Direct ..	Jet condensers	H.P. vul. bit., L.P. ld arm'd all con.	24,603 8 c p.	64 arcs	6,803....	Ltg 6d. and 2d. or 5d., power 2½d.	Brighton	Thomson & Aron	1,100	Lanarkshire dross	
s; 2	3 Westinghouse, 5 Ferranti..	2 100 kw., 1 500 kw., D C.; 2 100 kw., 1 500 k.w., A.C.	Direct coupled	Sea water, ejector condenser	Ld. cov. paper, con. and twin, armd. and in ducts.	34 arcs, 15,000 8 c.p.	74 arcs....	3,000....	4½d.	No discts. or scale	Shallenberger and Aron	1,200	Welsh steam coal	
urbo	Ferranti, Parsons and Richardson	3 212 kw., 1 150 kw., 2 600 kw.	Direct ..	Condensing....	Con., in conduits, and B.I.W. solid	24 arcs, 71,000 8 c.p.	264 arcs, 470 32 c.p., & 16 16 c.p.	—	4½d. lighting, 2½d. power	—	Shallenb'r, Thomson & Hookham	1,986	Small bituminous	
i.h.p.	Ferranti, Mordey and Johnson and Phillips A.C., Dick Kerr D.C.	2 54 kw., 2 120 kw., A.C.; 1 373 kw., D.C.	Ropes and direct	Surface condensing	B.I.W. lead cov., armd. and solid	2 arcs, 6,200 incands.	23 arcs, 218 incand.	1,100....	Ltg. 5d. & 3d., power 1d.	Sliding scale	Thomson and Shallenberger	348 A.C. 378 D.C.	Steam coal	
ond.;	Hall altrnatrs., E.C.C. Dynamos	125 kw., 200 kw. ..	Direct ..	Condensing....	A.C. conc. arm'rd, single distrs.	31,000 8 c.p.	—	6,000....	Ltg. 6d. to 4d., power. 3d. to 1½d.	Discounts & time sw.	Hookham, Thomson and Westinghouse	975	Welsh steam coal	
emier	Johnson-Phillips	2 100 kw., 1 35 kw...	Link belts	—	Lead cov. paper, conc. in ground (H.P. armd.)	4 arcs, 7,320 8 c.p.	290 32 c.p.	2,820....	5½d., 5d. 5 p.m. till 10 p.m., 2d aft., 2d. pwr.	—	Hookham & Aron	235	Anthracite	
h.p.	Brush, Nalder and Harrison	1 50 kw., 1 35 kw. ..	Belts....	—	Concentric, lead covered....	2 arcs, 4,000 8 c.p.	—	—	5d. and 4d., + fixed charge	Meter ..	Shallenberger, Hookham & Aron	85	Coal and coke	
1 250	Mather and Platt	4 120 kw.....	Ropes and direct	Condensing and non-condensing	Paper (B.I.W.) and fibrous, arm'rd and drawn in	59,000	3 arcs	11,000 ..	Ltg. 6d. & 2d., pwr. 3½d. & 1d.	Sliding scale	Shallenberger, Thomson and Hookham	480, 4 500 kw hr. batrs.	Gas coke ..	
kw.,	Parsons	4 150 kw., 1 75 kw.	Direct ..	Jet and surface	H.P. Silvertn. in c.i. pipes, L.P., B.I.W. con.	33,343 8 c.p.	—	6,172....	6½d. to 5½d., ovr. £75, 7d. & 3d., pwr. 2½d.	Discounts	Hookham, Thomson and Shallenberger	675	Steam coal	
nsion	Ferranti, Brush and Parsons	1 125 kw., 2 300 kw., 1 500 kw., 1 600 kw., 1 1,100 kw.	Direct ..	Condensing....	B.I.W. paper cables and bitumen conduit	123,496 8 c.p.	—	23,926 ..	Lighting 4d., power 2d.	Uniform charge	Thomson & Aron	2,925	Hard slack	
h.p., elliss	Ferranti and Bruce Peebles	2 125 kw., 1 300 kw., 1 600 kw., A.C.; 2 200 kw., D.C.	Direct ..	Condensing....	Paper (B.I.W.) and jute, lead cov., arm'd conc., D.C. Callender solid	52,243	43 arcs, 15 amp.	9,865....	6d., 4d., & 2d. for lighting 4d. & 2d. pwr.	Brighton	Shallenberger, Thomson, Hookham & Aron	1,150 A.C., 400 D.C.	Slack	
2 400	Ferranti, Siemens, Brown Boveri	2 100 kw., 2 200 kw., 2 500 kw.	Direct ..	Condensing....	Rub. conc., and B.I.W. paper in c.i. pipes	30,983 8 c.p.	87 arcs and 300 incandescent	9,844....	Ltg. 7d. & 2d., power 2d.	Brighton	Thomson and Hookham	1,600	Unscreened coal	
ss; 2 h.p.,	Thomson-Houston	2 150 kw., 2 75 kw., 1 33 kw., 1 33 kw. D.C.	Direct coupled	Jet condensers	Armoured concentric B.I.W cables	20,020 8 c.p.	72 arcs, 202 16 c.p.	6,025....	6d. to 3d.	Brighton	Thomson	450	Welsh coal	
.....	Fynn inductor alternators ..	125 kw. each	Direct ..	Condensing....	B.I.W. concentric solid, arm'rd and in ducts	12,026 8 c.p., 1 arc	52 arcs, 110 incands.	2,070....	7d. first hour, 3d. after	Wright's	Aron, Thomson and Hookham	375	Coal	
.....	Johnson and Phillips and Ferranti	1 500 kw., 1 400 kw., 3 80 kw., 1 40 kw.	Direct ..	Condensing....	Armoured concentric cables	36,000 8 c.p.	70 arcs, 300 incands.	9,000 ..	Ltg. 6d. & 3d., power 3d.	Demand system	Aron, Westnghse., Hookham and Thomson	1,180	Welsh coal, 36/6 ton	
h p.,	Fowler.....	3 112 kw., 1 28 kw.	Direct ..	Jet condensing	Arm'rd triple conc., and 3 core B.I.W.	16,300	16 arcs	2,300....	4½d., less 2½ %	Flat rate	Thomson	390	Smudge coal	
p., 1 wett-	Ferranti	2 75 kw., 1 200 kw., 2 300 kw.	Direct ..	Condensing....	B.I.W. armoured	14,711 8 c.p.	19 arcs	5,398....	6d. to 4d.; free wg. 7d. to 5d.	Sliding scale	Westinghouse and Hookham	650	Coke.....	
ersal;	Mordey inductor alternators and Ferranti	1 300 kw., 2 150 kw., 1 30 kw.	Direct coupled	Non-condensing	Henley's armoured concentric	7,000 8 c.p.	Equivalt. of 2,000 8 c.p.	700	8d. and 3d.	Wright's mx. dmd.	Hookham & Aron	630	Nottingham steam coal	
h.p.,	Ferranti	1 100 kw., 3 200 kw., 2 1,200 kw.	Direct ..	Condensing....	B.I.W. con. ld. cov. arm. and in pipes	34,243 8 c.p.	88 enc. arcs, 56 8 c p.	12,230 ..	Ltg. 7d. & 2d., pwr. 5d. & 1d.	Wright's	Thomson	3,100	Small coal & nuts	
illans	Crompton-Brunton	3 120 kw., 1 350 kw.	Direct ..	Non-condensing, at present	Paper conc. lead covd., arm'd and unarm'd	22,970 8 c.p.	903 incand = 4,108 8 c.p.	12,502 ..	7d 1½ hours, 2d. after	Maximum demand	Shallenberger and Electrical Co.	710	Welsh coal	
h.p.,	Parsons, Brush and E.C.C...	2 75 kw., 1 150 kw.	Direct ..	Surface condensing	Vulc. rubber and Callender ld. cov. and arm'rd conc.	5 arcs, 11,660 8 c.p.	123 incands. 25 c.p.	1,700....	8d. first 20 unt., 7d. after	Disct. on quantity	Shallenberger, Thomson and Hookham	300	Welsh coal	
, Vic. nti; 3 Belliss h.p., he	Mordey and Ferranti	4 125 kw., 1 400 kw.	Ropes and direct	Condensing....	Brooks, B.I.W. and Callender	28 arcs, 34,494 8 c.p.	57 arcs, 15 incands.	3,500 (approx.)	6½d. and 3d.	Brighton	Hookham and Thomson	900	Thr. & thr. Welsh	
	Crompton	3 150 kw., 3 75 kw., 1 15 kw., 4 15 kw. (arc lighters)	Direct and rope	Surface condensers	Concentric, B.I.W. paper ..	24,569 8 c.p.	77 arcs	5,067....	Ltg. 6d. & 4d., power 3½d.	—	Shallenbr., Thomson & Hookham	735	Welsh coal	
.....	Electric Construction Co. and Johnson-Phillips	125 kw., and 250 kw.	Direct ..	Preparing for condensing	B.I.W.....	64 arcs, 14,624 incs	None	7,919....	6d., with discounts	Flat rate	Westinghouse and Hookham	750	Welsh	
Allis, owett-	Mordey, Ferranti, British Thom house	400 kw. to 1,800 kw.	Direct ..	Condensing....	Concentric B.I.W. cables, etc.	510,000 8	508 arcs.	80,000 ..	8d. to 2d.....	Sliding	Thomson and Aron	—	Small and	

producers | tandem gas engines

..	Condensing....	Concentric B.I.W. cables, etc.	510,000 8 c.p.	508 arcs, Markets 41	80,000 ..	8d. to 2d.....	Sliding scale	Thomson and Aron	—	Small and large Welsh	£712,887 (1899)	£488,747 (1899)	—	—	—

	Welsh coal			out				erected and mains extd., £250,000		Dublin.....(25)	
112	Pea and Welsh coal	£99,652, to Mr. 31, 1900	£49,873	9/10	None	40	102 v.	9	Superheaters being fitted to all boilers	J. Douglas Knight	**Ealing**.....(26)
690	Large Welsh coal	£71,500	£16,020	6/7	3,131 8 c.p. eq. 200 v.	83	100 v. and 200 v.	17 = 9 h.p.....	Will change to 2,000 v., 50 v., 200 v., dec.p. New stn. bdg., 800 kw. plt. or.	J. K. Brydges ..	**Eastbourne** ....(27)
265	Coal, burgie & sl'ck mixed	£9,250	£4,897	Pr. 1/11, pub. ltg. 12/6	—	50	200 v.	None	—	James Moss....	**Eccles**† .....(28)
670	Welsh coal	—	—	—	None at present	100	100 v.	10 = 22 h.p. ..	—	H. D. Munro ..	**Exeter**.....(29)
140	Welsh coal, smll. house	£11,000	£4,000 (about)	10/–	None	125	100 v.	—	—	Arthur Blake ..	**Fareham** .....(30)
300	Yorkshire coal	£93,000		6/9	All new consumers	80	230 v.	About 120 h.p.	D.C. in central area, A.C. for outlying districts	H. F. Street ..	**Halifax** ..... (31)
224	Slack	£73,330	£25,000	5/5	1,500.....	100	100 v. and 200 v.	33 = 33½ h.p. ..	—	C. A. Cowell ..	**Hanley** .....(32)
850	Small steam coal (nuts)	£35,000	£13,600	Abt. 6/–	—	50	100 v. and a few 200 v.	75 h.p.	50 h.p. D.C. plant for pumping sewage	G. Wilkinson ..	**Harrogate** ....(33)
785	Small Welsh	About £100,000	—	9/–	—	100	200 v.	3 = 1½ h.p.....	—	L. Andrews....	**Hastings** .....(34)
290	Slack	£75,000	£65,000	5/–	—	100	100 v. and 200 v.	65 = 160 h.p...	—	A. B. Mountain	**Huddersfield** ..(35)
—	—	—	—	—	—	—	—	—	—	A. W. Thomas	**Keswick**† .....(36)
165	Slack	—	—	8/–	None	100	100 v.	—	Rubber cables being replaced by concentric armoured	L. C. Trevor-Roper	**Killarney** .....(37)
650	Small coal, lrg. Welsh	£33,549	£24,074	9/–	None	77	105 v.	3 = 6 h.p.	Cables to riverside for launch charging with D.C.	J. E. Edgcome	**Kingston-on-Thames** (38)
80	Coal.....	£11,000	—	—	None	100	100 v.	—	—	M. G. Smyth ..	**Larne** .....(39)
320	Local coal..	—	—	7/2	—	83	100 v. and 200 v.	200 h.p.	—	H. Dickinson ..	**Leeds** .....(40)
400	Coke..,....	—	—	6/–	About 6,000....	50	100 v. and 200 v.	51 = 101 h.p...	Total connection 71,362, equiv. 8 c.p.	A. Colson.....	**Leicester** ..... (41)
240	—	About £7,000	—	10/–	—	100	220 v.	—	—	J. E. Ritter....	**Limavady** .....(42)
147	Welsh coal	—	—	—	—	83 and 100	100 v. and 84 v.	None	Steam plant has never been used yet	P. T. Kimmins	**Lynton and Lynmouth (43)**
50	—	—	—	—	All.....	—	230 v.	—	—	L. O'Connor ..	**Macroom (Cork)** (44)
42	Frst.of Dean steam coal	—	—	6/7½	None	60	102 v.	2 = 10 b.h.p. (sewage pumpg.)	Third generating set on order	A. W. Blake ..	**Monmouth**.....(45)
140	Slack	£22,000	About £5,000	—	All.....	60	200 v.	5 = 25 h.p.	—	Herbert Drewett	**Morley** .....(46)
600 A.C., D.C.	Small steam	£69,971	£37,006	About 6/6	None	80	100 v. A.C., 480 & 240 v. D.C.	11 A.C. = 80 h.p., D.C. about 400 h.p.	* D.C. for power, 2½d. and 1d.	W. D. Hunter..	**Newcastle-on-Tyne**‡ (47)
370	Small steam	—	—	—	—	100	100 v. or 50 v. and 240 v.	—	J. S. Watson (Genl. Man.) W. M. H. Birtwood (Outside Man.)	D. Walker (Station Man.)	**Newcastle-on-Tyne** (48)
050	Abercarn small coal	£64,555	£24,247	5/8	—	87·5	200 v. and 100 v.	About 12 e.h.p.	—	C. D. Copland	**Newport**.....(49)
100	Lanarkshire dross	£95,000	£21,000	—	All, except in three cases	50	200 v.	4 = 24 b.h.p. ..	—	C. F. Parkinson	**Paisley** .....(50)
200	Welsh steam coal	£92,900	£16,000	—	3,000.....	50	100 v. and 200 v.	40 = 25 h.p., 2 = 1½ h.p., 3 = ½ h.p.	Traction and lighting from same engines	E. G. Okell....	**Plymouth** ‡.....(51)
986	Small bituminous	£140,000		7/6	None	50	100 v.	50 h.p.	—	E. Price	**Portsmouth** ....(52)
3 A.C. 3 D.C.	Steam coal	£33,000		5/–	None	100	100 v.	4 = 16 h.p. A.C., 41 h.p. D.C.	15 h.p. used for heating	G. H. Nisbett (ch.) R. P. Nash (res.)	**Prescot District**‡ (53)
975	Welsh steam coal	£55,000	£30,000	5/6	25,000	67	100 v. and 200 v.	12 = 97 b.h.p.	A.C. only in outlying districts	A. T. Cooper ..	**Reading** .....(54)
235	Anthracite	£18,911*		—	—	66	200 v.	10 = 56 h.p. ..	* Includes additional 100 kw. set now on order	W. J. Ferguson	**Redditch** .....(55)
85	Coal and coke	£4,950		6/–	None	100	100 v.	None	—	A. E. Lee.....	**Rugby**.....(56)
480, 000 kw batrs.	Gas coke ..	£150,000	£37,000	—	—	75	200 v., 220 v. and 440 v.	About 250 h.p.	New station nearing completion ; 8 900 kw. sets, 7 200 kw.	C. D. Taite....	**Salford** .....(57)
675	Steam coal	£28,387	£24,072	4/8	609	80	100 v. and 200 v.	7 = 28 h.p.....	—	F. G. Holden ..	**Scarborough** ..(58)
925	Hard slack	£390,000		4/7	35,000 8 c.p. ..	100	100 v. and 200 v.	250 h.p.	—	S. E. Fedden ..	**Sheffield**.....(59)
50 A.C., D.C.	Slack	£49,771	£50,365	4/11	All outlying districts	50	100 v. and 210 v.	6 = 44½ h.p. ..	Large extensions, including electric tramways, in hand	R. S. Downe ..	**Southport** ‡ ....(60)
600	Unscreened coal	£100,000	£30,000	6/1	—	50	110 v. and 220 v.	10 h.p.	—	J. A. Jeckell ..	**South Shields** ..(61)
450	Welsh coal	—	—	—	Extensions, 3,000	60	102½ v. and 205 v.	60 b.h.p.	—	E. J. B. Thornhill	**Taunton** .....(62)
375	Coal.....	£24,969	£5,589	—	All.....	50	200 v.	2 = ½ h.p.	Plant to be increased by 300 kw.	P. Storey.....	**Torquay**.....(63)
180	Welsh coal, 36/6 ton	£56,000	£14,000	5/2	All.....	67·5	220 v.	2 2 h.p.	Large extensions in hand	H. L. P. Boot ..	**Tunbridge Wells** (64)
390	Smudge coal	£32,000	£8,000	5/7	All.....	60	200 v.	7 h.p.	Extension in hand £25,000; 400 kw. on order	Robert Blackmore	**Wakefield** .....(65)
650	Coke.....	£34,473 (31/3/'00)	£8,670	—	None	50	100 v.	5 = 10 h.p.....	—	J. H. Crowther	**Wallasey**..... (66)
630	Nottingham steam coal	—	—	—	All.....	50	200 v.	3 = 3½ h.p.....	—	W. H. F. Colebrook	**Watford** .....(67)
100	Small coal & nuts	£47,247	£29,242	—	—	50	100 v. and 200 v.	9 = 100 h.p.	—	J. K. Bock	**West Ham**.....(68)
710	Welsh coal	About £50,000	About £25,000	—	All.....	50	220 v.	75 e.h.p.	Large extensions now in progress, including condensing plant	F. B. Spencer	**Wimbledon** ....(69)
300	Welsh coal	—	—	—	35	100	100 v. and 200 v.	None.....	All extensions 200 v.....	J. G. McLean..	**Woking** .....(70)
900	Thr. & thr. Welsh	£74,000 (approx.)	—	3/11½	About 2,500 of 200 v.	100	100 v. and 200 v.	66⅔ h.p.	—	C. J. Sutherland	**Worcester**..... (71)
735	Welsh coal	—	—	6/6	None	83·5	100 v.	About 27 h.p. ..	—	Gordon Bryant	**Yarmouth**.....(72)
											LONDON.
750	Welsh	—	—	—	—	—	200 v.	7 = 39 e.h.p. ..	W. Huskisson (Works Engineer)	J. A. Constable (Resident)	**Blackheath and Greenwich** (73)
—	Small and	£712,887	£488,747	—	—	—	204 v. A.C.	967 kw.	—	Frank Bailey ..	**City** ‡ .....(74)

lev. Ferranti, om	British	400 kw. to 1,800 kw.	Direct	Condensing....	Concentric B.I.W. cables, etc.	510,000	8	508	arcs.	80,000 ..	8d. to 2d.....	Sliding	Thomson and Aron	—	Small a

			producers	tandem gas engines						
(56) Rugby	Rugby School Elec. Ltg. Co.	House transformers	Dowson gas producers	Gas engines, 1 80 h.p., 1 65 h.p.	Brush, Nalder and Harrison	1 50 kw., 1 35 kw. ..	Belts....	—
(57) Salford	Corporation	Sub-statn. and house trans., & bat. sub-sta.	12 Lancs ..	3 250 h.p., Browett-Lindley; 1 250 h.p., Mather-Platt	Mather and Platt	4 120 kw.....	Ropes and direct	Condens non-cor
(58) Scarborough ..	Scarborough Electric Supply Co., Ltd.	Sub-station and house transformers	4 Lancs. ..	Parsons turbines, 4 150 kw, 1 75 kw.	Parsons	4 150 kw., 1 75 kw.	Direct ..	Jet and s
(59) Sheffield	Corporation	Sub-stations	Water tube & marine	Compound and triple expansion and Parsons turbine	Ferranti, Brush and Parsons	1 125 kw., 2 300 kw., 1 500 kw., 1 600 kw., 1 1,100 kw.	Direct ..	Condensi
(60) Southport ‡....	Corporation	Sub-stations	9 Lancs. ..	2 250 h.p., 1 500 h.p., 1 1,000 h.p., Musgrave; 2 330 b.h.p, Belliss	Ferranti and Bruce Peebles	2 125 kw., 1 300 kw., 1 600 kw., A.C.; 2 200 kw., D.C.	Direct ..	Condensi
(61) South Shields..	Corporation	Sub-stations	Marine....	Triple expansion, 2 200 h.p., 2 400 h.p., 2 1,000 h.p.	Ferranti, Siemens, Brown Boveri	2 100 kw., 2 200 kw., 2 500 kw.	Direct ..	Condensi
(62) Taunton	Corporation	Sub-stats. and house trans.	3 B. & W., 1 Paxman	2 300 h.p., 1 200 h.p., Belliss; 2 135 h.p., Willans; 1 50 h.p., Chandler	Thomson-Houston	2 150 kw., 2 75 kw., 1 33 kw., 1 33 kw. D.C.	Direct coupled	Jet conde
(63) Torquay	Corporation	Street trans. & sub-stations	B. & W. ..	3 250 h.p., Willans	Fynn inductor alternators ..	125 kw. each	Direct ..	Condensi
(64) Tunbridge Wells	Corporation	Sub-stations	5 Wr. tb. with s. htrs., 2 Lancs.	Willans and Ferranti	Johnson and Phillips and Ferranti	1 500 kw., 1 400 kw., 3 80 kw., 1 40 kw.	Direct ..	Condensi
(65) Wakefield	Corporation	Sub-stations	2 Lancs. ..	3 180 b.h.p., Fowler; 1 50 b.h.p., Belliss	Fowler.....	3 112 kw., 1 28 kw.	Direct ..	Jet conde
(66) Wallasey	Urban District Council	Sub-station & house trans.	3 Lancs., 1 water tube	Compound vertical, 2 125 h.p., 1 300 h.p., 2 500 h.p., Browett-Lindley and Ferranti	Ferranti	2 75 kw., 1 200 kw., 2 300 kw.	Direct ..	Condensi
(67) Watford	Urban District Council	Sub-station & street trans.	3 B. & W...	2 250 h.p., 1 50 h.p., Universal; 1 500 h.p., Ferranti	Mordey inductor alternators and Ferranti	1 300 kw., 2 150 kw., 1 30 kw.	Direct coupled	Non-cond
(68) West Ham	Corporation	Sub-stations & trans. boxes	4 Lancs. & 3 B. & W.	1 175 h.p., 3 350 h.p., 2 2,000 h.p., Ferranti	Ferranti	1 100 kw., 3 200 kw., 2 1,200 kw.	Direct ..	Condensi
(69) Wimbledon....	Urban District Council	Sub-stations	4 B. & W ..	3 200 i.h.p., 1 560 i.h.p., Willans	Crompton-Brunton	3 120 kw., 1 350 kw.	Direct ..	Non-cond at prese
(70) Woking.....	The Woking Elec. Supply Co., Ltd.	Sub-statn. and street trans.	2 Hornsby w t., 3 Renshaw	1 120 h.p., Belliss; 1 120 h.p., Parsons; 1 240 h.p., Allen	Parsons, Brush and E.C.C...	2 75 kw., 1 150 kw.	Direct ..	Surface c
(71) Worcester	Corporation	Sub-stations & house trans.	Water tube boilers	2 54 h.p., 1 48 h.p., 1 36 h.p., Vic. turbines; 1 700 h.p., Ferranti; 3 286 h.p., Brush; 1 120 h.p., Belliss	Mordey and Ferranti	4 125 kw., 1 400 kw.	Ropes and direct	Condensi
(72) Yarmouth	Corporation	Sub-stations	4 B. & W.	2 300 h.p., 3 150 h.p., 2 60 h.p., Willans; 1 300 h.p., Peache	Crompton	3 150 kw., 3 75 kw., 1 15 kw., 4 15 kw. (arc lighters)	Direct and rope	Surface c
LONDON.								
(73) Blackheath and Greenwich	Blackheath and Greenwich District Electric Light Co., Ltd.	Two-phase A.C. & D.C.	3 B. & W...	2 Belliss; 2 Clench	Electric Construction Co. and Johnson-Phillips	125 kw., and 250 kw.	Direct ..	Preparing cond
(74) City ‡	City of London Electric Lighting Co.	Sub-stations & direct current	B. & W. and marine	Brush, Willans, Ferranti, Allis, Musgrave, Sissons, Browett-Lindley, Chandler	Mordey, Ferranti, British Thomson-Houston, Westinghouse	400 kw. to 1,800 kw.	Direct ..	Condensi
(75) Hammersmith	Borough Council	Sub-stations, 2 wire dist.	6 water tube, 1 Lancs.	3 220 h.p., McLaren; 1 50 h.p., Belliss; 3 500 i.h.p., Robey	5 Ferranti copper type, 2 E.C.C. ironclad	1 25 kw., 3 125 kw., 3 300 kw.	Direct coupled	Condensi
(76) Hampstead....	Borough Council	Sub-stations, 3 wire dist.	4 Lancs., 4 Ellis-Eaves	2 290 h.p., 2 145 h.p., 2 560 h.p., Willans; 2 80 h.p., 2 800 h.p., Belliss; 2 560 h.p., Ferranti, etc.	Siemens and Ferranti	2 200 kw., 2 100 kw., 4 350 kw., 2 50 kw., 2 500 kw., 2 625 kw.	Direct ..	Non-cond (2,000 h be conde
(77) Islington	Borough Council	Street trans., 2 wire dist.	8 Lancs., 10 w. t.	4 hor. 250 i.h.p., 3 hor. 500 i.h.p., 1 vert. 80 i.h.p., and 3 1,000 h.p.	Ferranti and Fowler.....	4 125 kw., 1 40 kw., 3 300 kw., 3 600 kw.	Direct and ropes	Condensi plant on
(78) Kensington	Brompton and Kensington Elec. Supply Co., Ltd.	Sub-stats. and street trans.	19 boilers..	2 625 h.p., 5 325 h.p., 2 250 h.p., 2 140 h.p.	E.C.C.	2 350 kw., 5 200 kw., 2 150 kw., 2 80 kw.	Direct ..	1,000 h.p densing
(79) Kensington and Notting Hill	Committee of the K. & K and N.H. Companies	Three-phase A.C., mains to sub-stns.	5 B. & W., 3,500 h.p.	2 65 h.p., 3 575 h.p., 2 825 h.p., Willans	Oerlikon inductor alternators	3 330 kw., 2 550 kw., 2 40 kw., exciters	Direct ..	Korting condens
(80) Lambeth	South London Electric Supply Corporation	Street box transformers	8 B. & W ..	2 2,000 h.p., 2 400 h.p., Ferranti; 1 750 h.p., Yates-Thom	4 Ferranti, 1 British Thomson-Houston	2 250 kw., 2 1,000 kw., 1 500 kw.	Direct ..	Non-cond
(81) London	London Electric Supply Corporation	Sub-statn. and house transformers	Water tube and Economic	Hick Hargreaves, and Plenty & Son	Ferranti	—	Ropes and direct	Condensi
(82) Paddington, Marylebone, etc.	Metropolitan Electric Supply Co.	Sub-station & house trans. and direct	Water tube and marine	Willans, Allen, Hornsby, Parsons, Westinghouse	Kapp, Johnson-Phillips, Siemens, Latimer Clark, Parker, Parsons and Westinghouse	120 to 1,500 kw.	Direct and ropes	Both....
(83) St. Luke's and Clerkenwell ‡	County of London and Brush Prov. Electric Lighting Co.	1 and 2-phase A.C. sub-stn. and D.C.	12 B. & W.	11 vert. comp. 250 h.p., Brush; 2 horiz. cross compound, Allis	5 Mordey, 6 E.C.C., and 2 B.T.H. direct current	11 150 kw., 2 525 kw.	Direct ..	Condensi
(84) Wandsworth ..	County of London and Brush Prov. Electric Lighting Co.	High & ex. hgh. presur. A.C., sub-station	8 B. & W...	8 Universal.....	Mordey	150 kw. and 400 kw.	Direct ..	Condensi

‡ Employing both Alternating and Continuous Current.
† No Return to hand.

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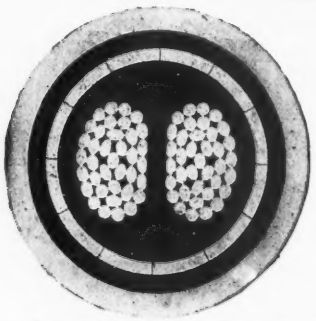

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NORTH WOOLWICH, E.;

CHICAGO, NEW YORK, PARIS, ANTWERP, BERLIN, ETC.

illips	2 100 kw., 1 35 kw...	Link belts	—	Lead cov. paper, conc. in ground (H.P. armd.	4 arcs, 7,320	290	32 c.p.	2,820....	1½d. 5½d., 5d. 5 p.m.	—	house Hookham & Aron	235	Anthracite		

—	Small and	£712,887	£488,747	—	—	—	204 v. A.C.	967 kw.	—	Frank Bailey ..	City‡ .....(74)						
		ground (H.P. armd.)	8 c.p.			till 10 p.m., 2d aft., 2d. pwr.				Anthracite	£18,911		—	—	66	20
elts....	—	Concentric, lead covered....	2 arcs, 4,000 8 c.p.	—	—	5d. and 4d., +fixed charge	Meter ..	Shallenberger, Hookham & Aron	85	Coal and coke	£4,950		6/–	None	100	10
opes and direct	Condensing and non-condensing	Paper (B.I.W.) and fibrous, arm'rd and drawn in	59,000	3 arcs	11,000 ..	Ltg. 6d. & 2d., pwr. 3½d. & 1d.	Sliding scale	Shallenberger, Thomson and Hookham	480, 4 500 kw hr. batrs.	Gas coke ..	£150,000	£37,000	—	—	75	20
irect ..	Jet and surface	H.P. Silvertn. in c.i. pipes, L.P., B.I.W. con.	33,343 8 c.p.	—	6,172....	6½d. to 5½d., ovr. £75, 7d. & 3d., pwr. 2½d.	Discounts	Hookham, Thomson and Shallenberger	675	Steam coal	£28,387	£24,072	4/8	609	80	10
irect ..	Condensing....	B.I.W. paper cables and bitumen conduit	123,496 8 c.p.	—	23,926 ..	Lighting 4d., power 2d.	Uniform charge	Thomson & Aron	2,925	Hard slack	£390,000		4/7	35,000 8 c.p. ..	100	10
irect ..	Condensing....	Paper (B.I.W.) and jute, lead cov., arm'd conc., D.C. Callender solid	52,243	43 arcs, 15 amp.	9,865....	6d., 4d., & 2d. for lighting 4d. & 2d. pwr.	Brighton	Shallenberger, Thomson, Hookham & Aron	1,150 A.C., 400 D.C.	Slack	£49,771	£50,365	4/11	All outlying districts	50	10
irect ..	Condensing....	Rub. conc., and B.I.W. paper in c.i. pipes	30,983 8 c.p.	87 arcs and 300 incandescent	9,844....	Ltg. 7d. & 2d., power 2d.	Brighton	Thomson and Hookham	1,600	Unscreened coal	£100,000	£30,000	6/1	—	50	1
irect coupled	Jet condensers	Armoured concentric B.I.W cables	20,020 8 c.p.	72 arcs, 202 16 c.p.	6,025....	6d. to 3d.	Brighton	Thomson	450	Welsh coal	—	—	—	Extensions, 3,000	60	10
irect ..	Condensing....	B.I.W. concentric solid, arm'rd and in ducts	12,026 8 c.p., 1 arc	52 arcs, 110 incands.	2,070....	7d. first hour, 3d. after	Wright's	Aron, Thomson and Hookham	375	Coal	£24,969	£5,589	—	All.....	50	2
irect ..	Condensing....	Armoured concentric cables	36,000 8 c.p.	70 arcs, 300 incands.	9,000 ..	Ltg. 6d. & 3d., power 3d.	Demand system	Aron, Westnghse., Hookham and Thomson	1,180	Welsh coal, 36/6 ton	£56,000	£14,000	5/2	All.....	67·5	2
irect ..	Jet condensing	Arm'rd triple conc., and 3 core B.I.W.	16,300	16 arcs	2,300....	4½d., less 2½ %	Flat rate	Thomson	390	Smudge coal	£32,000	£8,000	5/7	All.....	60	2
irect ..	Condensing....	B.I.W. armoured	14,711 8 c.p.	19 arcs	5,398....	6d. to 4d.; free wg. 7d. to 5d.	Sliding scale	Westinghouse and Hookham	650	Coke.....	£34,473 (31/3/'00)	£8,670	—	None	50	1
irect coupled	Non-condensing	Henley's armoured concentric	7,000 8 c.p.	Equivalt. of 2,000 8 c.p.	700	8d. and 3d.	Wright's mx. dmd.	Hookham & Aron	630	Nottingham steam coal	—	—	—	All.....	50	2
irect ..	Condensing....	B.I.W. con. ld. cov. arm. and in pipes	34,243 8 c.p.	88 enc. arcs, 56 8 c p.	12,230 ..	Ltg. 7d. & 2d., pwr. 5d. & 1d.	Wright's	Thomson	3,100	Small coal & nuts	£47,247	£29,242	—	—	50	1
irect ..	Non-condensing, at present	Paper conc. lead covd., arm'd and unarm'd	22,970 8 c.p.	903 incand = 4,108 8 c.p.	12,502 ..	7d 1½ hours, 2d. after	Maximum demand	Shallenberger and Electrical Co.	710	Welsh coal	About £50,000	About £25,000	—	All.....	50	2
irect ..	Surface condensing	Vulc. rubber and Callender ld. cov. and arm'rd conc.	5 arcs, 11,660 8 c.p.	123 incands. 25 c.p.	1,700....	8d. first 20 unt. 7d. after	Disct. on quantity	Shallenberger, Thomson and Hookham	300	Welsh coal	—	—	—	35	100	1
opes and direct	Condensing....	Brooks, B.I.W. and Callender	28 arcs, 34,494 8 c.p.	57 arcs, 15 incands.	3,500 (approx.)	6½d. and 3d.	Brighton	Hookham and Thomson	900	Thr. & thr. Welsh	£74,000 (approx.)	—	3/11½	About 2,500 of 200 v.	100	1
irect and rope	Surface condensers	Concentric, B.I.W. paper ..	24,569 8 c.p.	77 arcs	5,067....	Ltg. 6d. & 4d., power 3½d.	—	Shallenbr., Thomson & Hookham	735	Welsh coal	—	—	6/6	None	83·5	1
irect ..	Preparing for condensing	B.I.W.....	64 arcs, 14,624 incs	None	7,919....	6d., with discounts	Flat rate	Westinghouse and Hookham	750	Welsh	—	—	—	—	—	2
irect ..	Condensing....	Concentric B.I.W. cables, etc.	510,000 8 c.p.	508 arcs, Markets 41 arcs	80,000 ..	8d. to 2d.....	Sliding scale	Thomson and Aron	—	Small and large Welsh	£712,887 (1899)	£488,747 (1899)	—	—	—	2
irect coupled	Condensing....	H.P. Callender conc. in pipes, L.P. armoured	42,212 8 c.p.	164	—	Ltg. 6d. & 3d., pwr. 2½d. or 1/3 8 c.p. p.q.	Brighton, Manchstr. & contr'ct	Hookham	1,300	Welsh coal	£104,498*	£34,200*	—	None.....	50	1
irect ..	Non-condensing (2,000 h.p. to be condensing)	Siemens, Glover, and B.I.W. paper, Siemens and Glover 3 core	122,780 8 c.p.	81 open, 8 encl. arcs	22,329 .	6d. and 2½d.	Brighton	Thomson, Shallenberger, and Aron	4,456	Welsh coal	—	—	—	None	90	1
irect and ropes	Condensing, plant on order	Rubber concentric, steel arm'd	39,000 8 c.p. (approx.)	398 arcs, no incandsnt.	7,000....	7d. to 2d. ..	Maximum demand	Hookm., Westnhs., Thomson & Aron	2,700	Welsh coal	£350,000 (approx.)	£100,000 (approx.)	—	All extensions 200 v	50	1
irect ..	1,000 h.p. condensing	B.I.W. paper cables	108,978 8 c.p.	7 arcs, 14 incandescent	13,675 ..	Ltg. 6d., with dis.; power 3d.	Flat rate	Westinghouse, Thomson & Aron	2,160	Anthracite, &c.	—	—	—	None.....	83	1
irect ..	Korting ejector condensers	B.I.W. lead covd., 3 core in Doulton conduits	—	—	—	—	—	Thomson 3 phase	2,090	Small Midlands coal	£100,000		—	—	45	6
irect ..	Non-condensing	Lead cov. B.I.W. conc. in ducts and solid	44,000 8 c.p.	25 15 amp. arcs	18,000 ..	5½d.	Flat rate	Shallenberger and Thomson	3,000	Pea nuts ..	£240,000	£60,000	7/–	All.....	50	2
opes and direct	Condensing....	B.I.W. paper and jute	—	—	—	6d. p. unit with sliding scale, also demand indicator	Meter registration	Various	—	Welsh steam coal	—	—	—	—	83	2
irect and ropes	Both.....	B.I.W. paper and rub. cables	570,000 8 c.p.	20 arcs	70,000 ..	6d.	Sliding scale	Thomson, Shallenberger, and Aron	—	Welsh coal and slack	—	—	—	Not many, but extending	100 and 60	2
irect ..	Condensing....	H.P. B.I.W. conc. D.C. v. r. conc. and arm'd, in c.i. pipes	119,076 ..	—	—	Ltg. 7d. 1½ hrs., then 3d.; pwr. 2½d.	Brighton	Thomson	2,900	Small rough coal	—	—	—	—	100 and 50	1
irect ..	Condensing....	H.P. arm'rd, con. rub. L.P. lead cov. bitumenised fibre	90,472	—	—	Ltg. 7d. 1½ hrs., then 3d.; pwr. 2½d.	Brighton	Thomson and Shallenberger	1,700	Small rough coal	—	—	—	—	100 and 50	1

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PARIS,
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ELECTRIC INCANDESCENT LAMPS ARE

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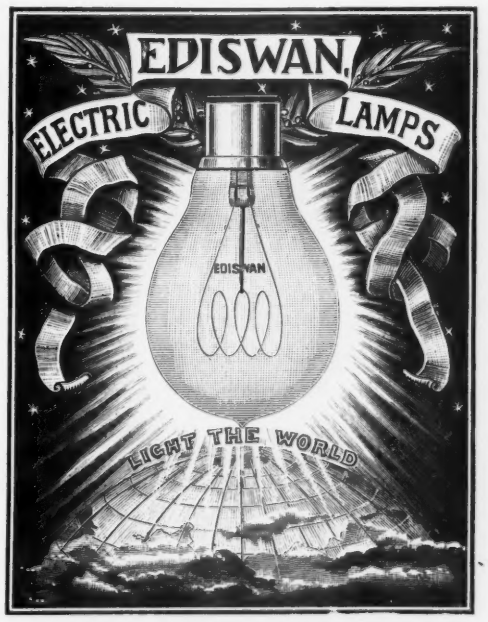

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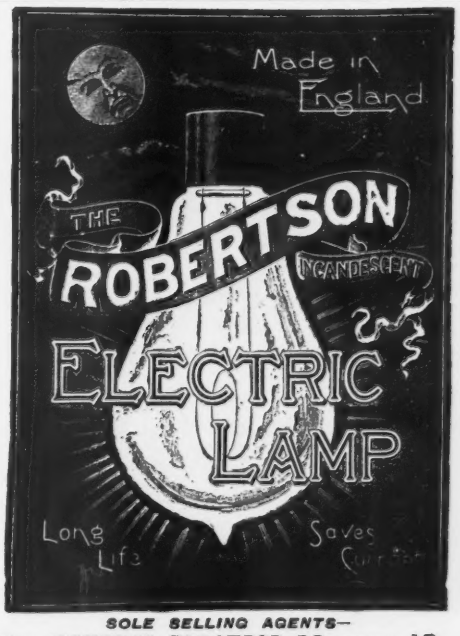

SOLE SELLING AGENTS—
THE GENERAL ELECTRIC CO. (1900), LD.,
71, Queen Victoria Street, London, E.C.

GLO
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MAN

35	Anthracite	£18,911*	—	—	66	200 v.	10 = 56 h.p. ..	* Includes additional 100 kw. set now on order	W. J. Ferguson	Redditch .....(55)		

nier	Johnson-Phillips	2 100 kw., 1 35 kw...	Link belts	—	Lead cov. paper, conc. in ground (H.P. armd.)	4 arcs, 7,320 8 c.p.	290 32 c.p.	2,820....	1½d. 5½d., 5d. 5 p.m. till 10 p.m., 2d aft., 2d. pwr.	—	house Hookham & Aron	235	Anthracite
p.	Brush, Nalder and Harrison	1 50 kw., 1 35 kw. ..	Belts....	—	Concentric, lead covered....	2 arcs, 4,000 8 c.p.	—	—	5d. and 4d., +fixed charge	Meter ..	Shallenberger, Hookham & Aron	85	Coal and coke
250	Mather and Platt	4 120 kw.....	Ropes and direct	Condensing and non-condensing	Paper (B.I.W.) and fibrous, arm'rd and drawn in	59,000	3 arcs	11,000 ..	Ltg. 6d. & 2d., pwr. 3½d. & 1d.	Sliding scale	Shallenberger, Thomson and Hookham	480, 4 500 kw hr. batrs.	Gas coke ..
kw.,	Parsons	4 150 kw., 1 75 kw.	Direct ..	Jet and surface	H.P. Silvertn. in c.i. pipes, L.P., B.I.W. con.	33,343 8 c.p.	—	6,172....	6½d. to 5½d., ovr. £75, 7d. & 3d., pwr. 2½d.	Discounts	Hookham, Thomson and Shallenberger	675	Steam coal
sion	Ferranti, Brush and Parsons	1 125 kw., 2 300 kw., 1 500 kw., 1 600 kw., 1 1,100 kw.	Direct ..	Condensing....	B.I.W. paper cables and bitumen conduit	123,496 8 c.p.	—	23,926 ..	Lighting 4d., power 2d.	Uniform charge	Thomson & Aron	2,925	Hard slack
p., liss	Ferranti and Bruce Peebles	2 125 kw., 1 300 kw., 1 600 kw., A.C.; 2 200 kw., D.C.	Direct ..	Condensing....	Paper (B.I.W.) and jute, lead cov., arm'd conc., D.C. Callender solid	52,243	43 arcs, 15 amp.	9,865....	6d., 4d., & 2d. for lighting 4d. & 2d. pwr.	Brighton	Shallenberger, Thomson, Hookham & Aron	1,150 A.C., 400 D.C.	Slack ....
400	Ferranti, Siemens, Brown Boveri	2 100 kw., 2 200 kw., 2 500 kw.	Direct ..	Condensing....	Rub. conc., and B.I.W. paper in c.i. pipes	30,983 8 c.p.	87 arcs and 300 incandescent	9,844....	Ltg. 7d. & 2d., power 2d.	Brighton	Thomson and Hookham	1,600	Unscreened coal
s; 2 p.,	Thomson-Houston	2 150 kw., 2 75 kw., 1 33 kw., 1 33 kw. D.C.	Direct coupled	Jet condensers	Armoured concentric B.I.W cables	20,020 8 c.p.	72 arcs, 202 16 c.p.	6,025....	6d. to 3d.	Brighton	Thomson.....	450	Welsh coal
...	Fynn inductor alternators ..	125 kw. each	Direct ..	Condensing....	B.I.W. concentric solid, arm'rd and in ducts	12,026 8 c.p., 1 arc	52 arcs, 110 incands.	2,070....	7d. first hour, 3d. after	Wright's	Aron, Thomson and Hookham	375	Coal .....
...	Johnson and Phillips and Ferranti	1 500 kw., 1 400 kw., 3 80 kw., 1 40 kw.	Direct ..	Condensing....	Armoured concentric cables	36,000 8 c.p.	70 arcs, 300 incands.	9,000 ..	Ltg. 6d. & 3d., power 3d.	Demand system	Aron, Westnghse., Hookham and Thomson	1,180	Welsh coal, 36/6 ton
h p.,	Fowler.....	3 112 kw., 1 28 kw.	Direct ..	Jet condensing	Arm'rd triple conc., and 3 core B.I.W.	16,300	16 arcs....	2,300....	4½d., less 2½ %	Flat rate	Thomson.....	390	Smudge coal
p., 1 vett-	Ferranti	2 75 kw., 1 200 kw., 2 300 kw.	Direct ..	Condensing....	B.I.W. armoured	14,711 8 c.p.	19 arcs....	5,398....	6d. to 4d.; free wg. 7d. to 5d.	Sliding scale	Westinghouse and Hookham	650	Coke.....
sal;	Mordey inductor alternators and Ferranti	1 300 kw., 2 150 kw., 1 30 kw.	Direct coupled	Non-condensing	Henley's armoured concentric	7,000 8 c.p.	Equivalt. of 2,000 8 c.p.	700	8d. and 3d.	Wright's mx. dmd.	Hookham & Aron	630	Nottingham steam coal
h.p.,	Ferranti	1 100 kw., 3 200 kw., 2 1,200 kw.	Direct ..	Condensing....	B.I.W. con. ld. cov. arm. and in pipes	34,243 8 c.p.	88 enc. arcs, 56 8 c p.	12,230 ..	Ltg. 7d. & 2d., pwr. 5d. & 1d.	Wright's	Thomson	3,100	Small coal & nuts
llans	Crompton-Brunton	3 120 kw., 1 350 kw.	Direct ..	Non-condensing, at present	Paper conc. lead covd., arm'd and unarm'd	22,970 8 c.p.	903 incand = 4,108 8 c.p.	12,502 ..	7d 1½ hours, 2d. after	Maximum demand	Shallenberger and Electrical Co.	710	Welsh coal
h.p.,	Parsons, Brush and E.C.C...	2 75 kw., 1 150 kw.	Direct ..	Surface condensing	Vulc. rubber and Callender ld. cov. and arm'rd conc.	5 arcs, 11,660 8 c.p.	123 incands. 25 c.p.	1,700....	8d. first 20 unt. 7d. after	Disct. on quantity	Shallenberger, Thomson and Hookham	300	Welsh coal
Vic. ti; 3 elliss	Mordey and Ferranti	4 125 kw., 1 400 kw.	Ropes and direct	Condensing....	Brooks, B.I.W. and Callender	28 arcs, 34,494 8 c.p.	57 arcs, 15 incands.	3,500 (approx.)	6½d. and 3d.	Brighton	Hookham and Thomson	900	Thr. & thr. Welsh
h.p.,	Crompton	3 150 kw., 3 75 kw., 1 15 kw., 4 15 kw. (arc lighters)	Direct and rope	Surface condensers	Concentric, B.I.W. paper ..	24,569 8 c.p.	77 arcs	5,067....	Ltg. 6d. & 4d., power 3½d.	—	Shallenbr., Thomson & Hookham	735	Welsh coal
....	Electric Construction Co. and Johnson-Phillips	125 kw., and 250 kw.	Direct ..	Preparing for condensing	B.I.W.....	64 arcs, 14,624 incs	None	7,919....	6d., with discounts	Flat rate	Westinghouse and Hookham	750	Welsh ....
Allis, wett-	Mordey, Ferranti, British Thomson-Houston, Westinghouse	400 kw. to 1,800 kw.	Direct ..	Condensing....	Concentric B.I.W. cables, etc.	510,000 8 c.p.	508 arcs, Markets 41 arcs	80,000 ..	8d. to 2d.....	Sliding scale	Thomson and Aron	—	Small and large Welsh
h.p.,	5 Ferranti copper type, 2 E.C.C. ironclad	1 25 kw., 3 125 kw., 3 300 kw.	Direct coupled	Condensing....	H.P. Callender conc. in pipes, L.P. armoured	42,212 8 c.p.	164	—	Ltg. 6d. & 3d., pwr. 2½d. or 1/3 8 c.p. p.q.	Brighton, Manchstr. & contr'ct	Hookham	1,300	Welsh coal
h.p., h.p., i, etc.	Siemens and Ferranti	2 200 kw., 2 100 kw., 4 350 kw., 2 50 kw., 2 500 kw., 2 625 kw.	Direct ..	Non-condensing (2,000 h.p. to be condensing)	Siemens, Glover, and B.I.W. paper, Siemens and Glover 3 core	122,780 8 c.p.	81 open, 8 encl. arcs	22,329 .	6d. and 2½d.	Brighton	Thomson, Shallenberger, and Aron	4,456	Welsh coal
h.p.. 0 h.p.	Ferranti and Fowler.....	4 125 kw., 1 40 kw., 3 300 kw., 3 600 kw.	Direct and ropes	Condensing, plant on order	Rubber concentric, steel arm'd	39,000 8 c.p. (approx.)	398 arcs, no incandsnt.	7,000....	7d. to 2d. ..	Maximum demand	Hookm., Westnhs., Thomson & Aron	2,700	Welsh coal
h.p.,	E.C.C.....	2 350 kw., 5 200 kw., 2 150 kw., 2 80 kw.	Direct ..	1,000 h.p. condensing	B.I.W. paper cables	108,978 8 c.p.	7 arcs, 14 incandescent	13,675 ..	Ltg. 6d., with dis.; power 3d.	Flat rate	Westinghouse, Thomson & Aron	2,160	Anthracite, &c.
h.p.,	Oerlikon inductor alternators	3 330 kw., 2 550 kw., 2 40 kw., exciters	Direct ..	Korting ejector condensers	B.I.W. lead covd., 3 core in Doulton conduits	—	—	—	—	—	Thomson 3 phase	2,090	Small Midlands coal
ranti;	4 Ferranti, 1 British Thomson-Houston	2 250 kw., 2 1,000 kw., 1 500 kw.	Direct ..	Non-condensing	Lead cov. B.I.W. conc. in ducts and solid	44,000 8 c.p.	25 15 amp. arcs	18,000 ..	5½d.	Flat rate	Shallenberger and Thomson	3,000	Pea nuts ..
nty &	Ferranti	—	Ropes and direct	Condensing....	B.I.W. paper and jute	—	—	—	6d. p. unit with sliding scale, also demand indicator	Meter registration	Various	—	Welsh steam coal
rsons,	Kapp, Johnson-Phillips, Siemens, Latimer Clark, Parker, Parsons and Westinghouse	120 to 1,500 kw.....	Direct and ropes	Both.....	B.I.W. paper and rub. cables	570,000 8 c.p.	20 arcs....	70,000 ..	6d.	Sliding scale	Thomson, Shallenberger, and Aron	—	Welsh coal and slack
rush; Allis	5 Mordey, 6 E.C.C., and 2 B.T.H. direct current	11 150 kw., 2 525 kw.	Direct ..	Condensing....	H.P. B.I.W. conc. D.C. v. r. conc. and arm'd, in c.i. pipes	119,076 ..	—	—	Ltg. 7d. 1½ hrs., then 3d.; pwr. 2½d.	Brighton	Thomson	2,900	Small rough coal
.....	Mordey	150 kw. and 400 kw.	Direct ..	Condensing....	H.P. arm'rd, con. rub. L.P. lead cov. bitumenised fibre	90,472	—	—	Ltg. 7d. 1½ hrs., then 3d.; pwr. 2½d.	Brighton	Thomson and Shallenberger	1,700	Small rough coal

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Western Electric Co.

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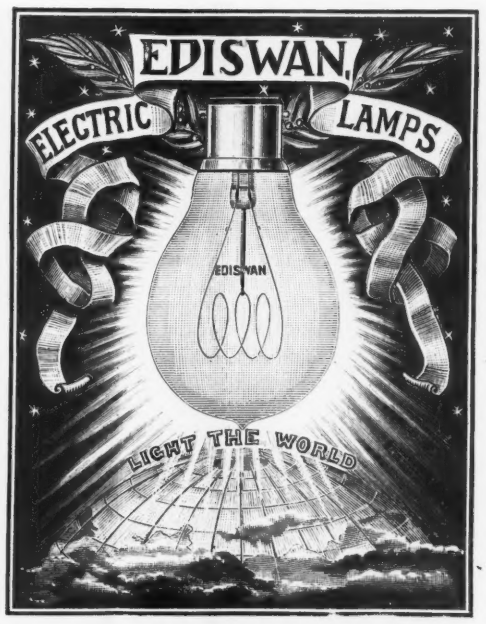

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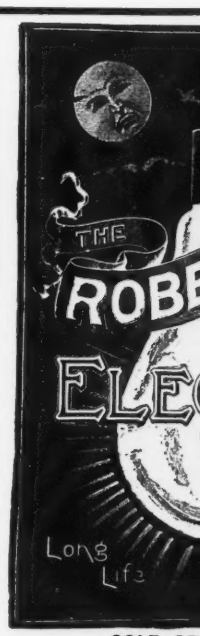
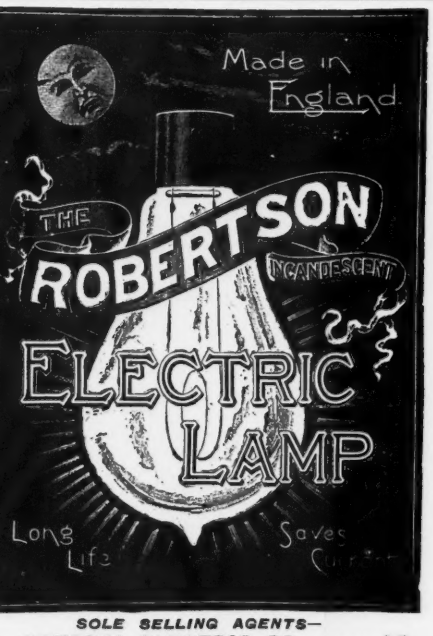


SOLE SE
THE GENERAL EL
71, Queen Victor

235	Anthracite	£18,911*	—	—	66	200 v.	10 = 56 h.p. ..	* Includes additional 100 kw. set now on order	W. J. Ferguson	**Redditch** .....(55)
85	Coal and coke	£4,950	6/–	None	100	100 v.	None	—	A. E. Lee.....	**Rugby**.....(56)
480, 500 kw batrs.	Gas coke ..	£150,000	£37,000	—	—	75	200 v., 220 v. and 440 v.	About 250 h.p.	New station nearing completion ; 8 900 kw. sets, 7 200 kw.	C. D. Taite....	**Salford** .....(57)
675	Steam coal	£28,387	£24,072	4/8	609	80	100 v. and 200 v.	7 = 28 h.p.....	—	F. G. Holden ..	**Scarborough** ..(58)
925	Hard slack	£390,000		4/7	35,000 8 c.p. ..	100	100 v. and 200 v.	250 h.p.	—	S. E. Fedden ..	**Sheffield**.....(59)
150 A.C., D.C.	Slack	£49,771	£50,365	4/11	All outlying districts	50	100 v. and 210 v.	6 = 44½ h.p. ..	Large extensions, including electric tramways, in hand	R. S. Downe ..	**Southport** ‡ ....(60)
600	Unscreened coal	£100,000	£30,000	6/1	—	50	110 v. and 220 v.	10 h.p.	—	J. A. Jeckell ..	**South Shields** ..(61)
450	Welsh coal	—	—	—	Extensions, 3,000	60	102½ v. and 205 v.	60 b.h.p.	—	E. J. B. Thornhill	**Taunton**.....(62)
375	Coal	£24,969	£5,589	—	All.....	50	200 v.	2 = ½ h.p.	Plant to be increased by 300 kw.	P. Storey.....	**Torquay**.....(63)
180	Welsh coal, 36/6 ton	£56,000	£14,000	5/2	All.....	67·5	220 v.	2 2 h.p.	Large extensions in hand	H. L. P. Boot ..	**Tunbridge Wells** (64)
390	Smudge coal	£32,000	£8,000	5/7	All.....	60	200 v.	7 h.p.	Extension in hand £25,000; 400 kw. on order	Robert Blackmore	**Wakefield**.....(65)
650	Coke.....	£34.473 (31/3/'00)	£3,670	—	None	50	100 v.	5 = 10 h.p.....	—	J. H. Crowther	**Wallasey**..... (66)
630	Nottingham steam coal	—	—	—	All.....	50	200 v.	3 = 3½ h.p.....	—	W. H. F. Colebrook	**Watford** .....(67)
1100	Small coal & nuts	£47,247	£29,242	—	—	50	100 v. and 200 v.	9 = 100 h.p.	—	J. K. Bock	**West Ham**.....(68)
710	Welsh coal	About £50,000	About £25,000	—	All.....	50	220 v.	75 e.h.p.	Large extensions now in progress, including condensing plant	F. B. Spencer	**Wimbledon** ....(69)
300	Welsh coal	—	—	—	35	100	100 v. and 200 v.	None.....	All extensions 200 v.....	J. G. McLean..	**Woking** .....(70)
900	Thr. & thr. Welsh	£74,000 (approx.)	—	3/11¼	About 2,500 of 200 v.	100	100 v. and 200 v.	66⅔ h.p.	—	C. J. Sutherland	**Worcester**..... (71)
735	Welsh coal	—	—	6/6	None	83·5	100 v.	About 27 h.p. ..	—	Gordon Bryant	**Yarmouth**.....(72)

LONDON.

750	Welsh	—	—	—	—	—	200 v.	7 = 39 e.h.p. ..	W. Huskisson (Works Engineer)	J. A. Constable (Resident)	**Blackheath and Greenwich** (73)
—	Small and large Welsh	£712,887 (1899)	£488,747 (1899)	—	—	—	204 v. A.C. and 400 v. D.C.	967 kw.	—	Frank Bailey ..	**City** ‡ .....(74)
1,300	Welsh coal	£104,498*	£34,200*	—	None.....	50	110 v.	40 = 74 h.p. ..	* March 25th, 1900	G. Gilbert Bell	**Hammersmith**..(75)
1,456	Welsh coal	—	—	—	None	90	105 v. and 100 v.	5 = 11 h.p. ..	2 950 h.p. sets erecting..	G. H. Cottam..	**Hampstead**.... (76)
1,700	Welsh coal	£350,000 (approx.)	£100,000 (approx.)	—	All extensions 200 v	50	100 v. and 200 v.	6 = 10 h.p.....	Figures approximate to March 31st, 1901	Albert Gay	**Islington** .....(77)
1,160	Anthracite, &c.	—	—	—	None.....	83	100 v.	About 20 on ltg. circuits	—	H. W. Bowden	**Kensington** ....(78)
1,090	Small Midlands coal	£100,000		—	—	45	Generating pressure 5,000 v.	11 motor generators = 3,000 h.p.	Energy supplied to the Kensington and the Notting Hill Cos. only	Joint engineers, H. W. Miller, G. Schultz	**Kensington and Notting Hill** (79)
1,000	Pea nuts ..	£240,000	£60,000	7/–	All.....	50	220 v.	—	—	H. W. Sprunt..	**Lambeth** .....(80)
—	Welsh steam coal	—	—	—	—	83	100 v.	—	—	G. W. Partridge	**London** ..... (81)
—	Welsh coal and slack	—	—	—	Not many, but extending	100 and 60	50 v., 100 v., 200 v.	—	—	R. R. Todd....	**Paddington, Marylebone, etc.** (82)
1,900	Small rough coal	—	—	—	—	100 and 50	100 v. and 530 v. D.C	—	—	C. P. Sparks ..	**St. Luke's and Clerkenwell** ‡(83)
1,700	Small rough coal	—	—	—	—	100 and 50	200 v.	—	—	C. P. Sparks ..	**Wandsworth** ..(84)



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